ADDENDUM #2

City Campus Utility Plant 2nd Floor Addition

City Campus
University of Nebraska – Lincoln
Lincoln, Nebraska

UNL Project No. C0028P243

UNL Invitation No. 2298-14-7200

UNIVERSITY OF NEBRASKA-LINCOLN
FACILITIES MANAGEMENT & PLANNING DEPARTMENT
FACILITIES PLANNING & CONSTRUCTION
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January 30, 2014

University of Nebraska Lincoln

ADDENDUM NO. 2

PROJECT NAME: City Campus Central Utility Plant – 2nd Floor Addition
UNL PROJECT NUMBER: C028P243
UNL INVITATION NUMBER: 2298-14-7200

Design Professionals:
Sinclair Hille Architects – Architects
UNL FPC. – Mechanical/Electrical Engineers
Structural Design Group – Structural Engineers

DATE OF ISSUANCE: Thursday, January 30, 2014

DATE OF BID OPENING: Tuesday, February 4, 2014—10:00 AM CST

The bid documents dated **12.20.13** for the above referenced project are amended by this addendum.

NOTICE: This Addendum is issued to all interested prospective bidders as an amendment to the project manual or other parts of the bidding (contract) documents for the above named project. Reference to this Addendum must be included in the Bid proposal. The information contained herein shall be fully incorporated into the contract documents as though originally included therein.

MODIFICATIONS TO THE DRAWINGS / PROJECT MANUAL

Sheet G1.01 – Drawing Standards & Room Finish/Door Schedules

1. Refer to Door Schedule. Doors 220.C1 & 220.D1 to receive HM2 Frame. All other HM door frames to be HM1 U.N.O.
2. Refer to Door Schedule/Types & Section 088000 - Glazing:
   a. Vision Lite for door 220.1 (45 minute rated assembly with a required STC rating of 40) shall be Technical Glass Products 3/4" thick, 45 minute fire rated Pyrostop.
   b. Vision Lite for Door 299A.1 (non-rated assembly with a required STC rating of 40) shall be 5/8" clear tempered laminated glass. Glass makeup to be 3/8" clear tempered, .030 PVB interlayer, ¼" clear tempered for an overall thickness of 5/8".

See Attached MEP Specifications for the following Divisions omitted from the Project Manual:

1. **22 05 00** - Basic Plumbing Requirements
2. **22 05 13** - Electrical Requirements for Plumbing Equipment
3. **22 05 29** – Plumbing Hangers and Supports
4. **22 05 53** – Plumbing Identification
5. **22 07 19** – Plumbing Piping Insulation
6. **22 10 00** – Plumbing Piping
7. **22 11 19** – Plumbing Specialties

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8. **22 400 00** – Plumbing Fixtures
9. **23 05 00** – Basic HVAC Requirements
10. **23 05 13** – Electrical Requirements for Mechanical Equipment
11. **23 05 19** – HVAC Meters and Gages
12. **23 05 29** – HVAC Hangers and Supports
13. **23 05 30** – HVAC Firestopping
14. **23 05 48** – HVAC Vibration Controls
15. **23 05 53** – HVAC Identification
16. **23 05 93** – Testing, Adjusting, and Balancing
17. **23 07 13** – Ductwork Insulation
18. **23 07 16** – HVAC Equipment Insulation
19. **23 07 19** – HVAC Piping Insulation
20. **23 09 00** – Digital Control Equipment
21. **23 09 01** – Instruments and Control Elements
22. **23 09 93** – Sequence of Operation for HVAC controls
23. **23 21 13** – Hydronic Piping
24. **23 21 16** – Hydronic Specialties
25. **23 21 23** – HVAC Pumps
26. **23 31 13** – Ductwork
27. **23 33 00** – Ductwork Accessories
28. **23 36 00** – Air Terminal Units
29. **23 37 00** – Air Outlets and inlets
30. **23 73 13** – Air Handling Units
31. **23 82 39** – Terminal Heat Transfer Units
32. **26 00 00** – Basic Electrical Requirements
33. **26 05 00** – Electrical General Provisions
34. **26 05 01** – Basic Materials and Methods
35. **26 05 19** – Conductors
36. **26 05 33** – Raceways
37. **26 27 26** – Wiring Devices
38. **26 51 00** – Lighting

END OF ADDENDUM NO. 2

SECTION 22 05 00 - BASIC PLUMBING REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

A. This section describes Basic Mechanical Requirements required to provide for a complete installation of all mechanical systems for this project. This section shall apply to all other Division 22 specification sections as well as all work shown on the drawings.

B. It is the intent of the Mechanical Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.

C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative.

D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.

E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

F. Note that the words "mechanical" and "plumbing" are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 22.

1.3 DESCRIPTION OF WORK

A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete mechanical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping fixtures, etc. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

1.4 PERMITS

A. All permits, fees, licenses, etc. required for this project shall be obtained by the Contractor.

1.5 QUALITY ASSURANCE

A. Installers shall have at least 2 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for

satisfactory operation, unless noted otherwise in other mechanical sections.

B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.

C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.

F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.

G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.6 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
3. ABMA - American Boiler Manufacturers Association.
4. ACCA - Air Conditioning Contractors of America.
5. ACGIH - American Conference of Governmental Industrial Hygienists.
6. ADC - Air Diffusion Council.
7. AGA - American Gas Association.
8. AIHA - American Industrial Hygiene Association.
9. AMCA - Air Movement and Control Association.
10. ANSI - American National Standards Institute.
11. ARI - Air-Conditioning and Refrigeration Institute.
12. ASA - Acoustical Society of American.
13. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
14. ASME - The American Society of Mechanical Engineers.
15. ASTM - American Society of Testing and Materials.
16. BOCA – Building Officials and Code Administrators International.
17. CABO – Council of American Building Officials.
18. CAGI - Compressed Air and Gas Institute.
19. CTI - Cooling Tower Institute.
20. EJMA - Expansion Joint Manufacturers Association.
21. ETL - Engineering Tests Laboratory.
22. HEI - Heat Exchange Institute.
23. HI - Hydraulic Institute.
24. HYD I - Hydronics Institute.

25. IAPMO – International Association of Plumbing and Mechanical Officials.
26. ICBO - International Conference of Building Officials.
27. ICC – International Code Council.
28. NEBB - National Environmental Balancing Bureau.
29. NEC - National Electrical Code.
30. NEMA - National Electrical Manufacturers Association.
31. NFPA - National Fire Protection Association.
32. NSF - National Sanitation Foundation.
33. SAE - Society of Automatic Engineers.
34. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
35. TEMA - Tubular Exchanger Manufacturers Association.
36. UL - Underwriters Laboratories, Inc.
37. International Plumbing Code.
38. International Mechanical Code.
39. Other governing, state, and local codes that apply.

1.7 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and “Special Conditions”.

B. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Mechanical Sections.

1. Certified performance and data with system operating conditions indicated. All coil, fan, and pump performance data shall be computer generated.
2. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
3. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.
4. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Maintenance Data: Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

C. Provide separate shop drawing submittals for the following items:

1. Section 22 05 00:

Submittal Requirement:	**Date Submitted:**
Plumbing permits	
Plumbing licenses	
EPA/ASHRAE 34 refrigeration certification	
Welding certificates	

Submittal Requirement:	**Date Submitted:**
Warranties	
As-built documents	
Pipe pressure test logs	
Operation and maintenance manuals (electronic copies integrated into EMCS)	
Close-out / walk-through documentation	
Training seminar documentation	

2. Section 22 05 19:

Submittal Requirement:	**Date Submitted:**
Flow meters	
Calibrated balance valves	
Pressure gauges	
Thermometers	
Pressure/temperature test plugs	

3. Section 22 05 29:

Submittal Requirement:	**Date Submitted:**
Pipe supports, anchors, sleeves, and hangers	
Equipment curbs, supports, and hangers	
Mechanical seals	
Roof curbs and supports	
Fire sealants	

4. Section 22 05 48:

Submittal Requirement:	**Date Submitted:**
Vibrations controls	

5. Section 22 05 53:

Submittal Requirement:	**Date Submitted:**
Plumbing identification materials	

Submittal Requirement:	**Date Submitted:**
Valve schedule	

6. Section 22 07 16:

Submittal Requirement:	**Date Submitted:**
Equipment insulation materials and insulation schedule	

7. Section 22 07 19:

Submittal Requirement:	**Date Submitted:**
Pipe insulation materials and insulation schedule	

8. Section 22 10 00:

Submittal Requirement:	**Date Submitted:**
Installer factory training and certifications for laboratory waste and vent piping	
Plumbing piping material and fitting schedule	
Plumbing valve material and schedule	
Plumbing pipe accessories	
Plumbing hydrostatic test report(s)	
Domestic water sample test report(s)	

9. Section 22 11 19:

Submittal Requirement:	**Date Submitted:**
Plumbing specialties, cleanouts, plumbing fixture carriers, etc.	
Backflow preventers and backflow preventer tests	

10. Section 22 30 00:

Submittal Requirement:	**Date Submitted:**
All scheduled plumbing equipment	

11. Section 22 40 00:

Submittal Requirement:	**Date Submitted:**
All scheduled plumbing fixtures and accessories	

12. Section 22 67 00:

Submittal Requirement:	**Date Submitted:**
Installer factory training and certifications	
Pure water piping material and fitting schedule	
Pure water valves	
Pure water pipe accessories	
Pure water hydrostatic test report(s)	

13. Section 22 67 01:

Submittal Requirement:	**Date Submitted:**
Pure water system equipment	

14. Section 22 95 00:

Submittal Requirement:	**Date Submitted:**
Plumbing commissioning documentation	

1.8 SUBSTITUTES

A. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified.

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing. Associated mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are to be increased accordingly, but all recommended manufacturer clearances, etc., are to be maintained within the allotted mechanical spaces. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

C. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.

D. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.

E. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.

F. Final determination regarding substitutions shall be by the Architect/Engineer.

1.9 WARRANTY

A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Mechanical Sections.

1.10 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.

C. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.

D. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.

E. All tests shall be made after notification to and in the presence of the Owner's representative.

F. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.

G. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.

H. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.

I. At the time of substantial project completion, turn over the prime responsibility for operation of the plumbing equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

J. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.11 AS-BUILT DOCUMENTS

A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:

1. The Plumbing Contractor shall provide the Owner with as-built drawings for ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units and indicate all devices requiring periodic

maintenance or repair, such as control power transformers, LACS panels/routers, field controllers, duct static pressure sensors, piping pressure sensors, etc.

2. All plumbing systems as described in the Specifications and/or shown on the drawings.
3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 22 Section "Plumbing Identification." Indicate actual inverts and horizontal locations of underground piping.
4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.

1.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

2. PRODUCTS (NOT APPLICABLE).

3. EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Use proper lifting equipment where size/weight requires handling by such means.

D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.

E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.

F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

G. Plumbing Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

3.2 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.3 COORDINATION

A. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Coordinate the plumbing work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
3. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.4 PLUMBING INSTALLATIONS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner's representative shall be notified and any changes approved before proceeding with the work.

D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form.

Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

I. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

K. Welding, sweating, or brazing operations

1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials cannot be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.
4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.5 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.7 PIPING SYSTEMS PRESSURE TESTING

A. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:

1. UNL Project Inspector

B. Removal of pressure charge and associated drain down shall also be witnessed.

C. Mechanical contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.

D. Pressure gauge requirements: Provide recently calibrated gauge with 4" face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.

E. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.

F. Entire system shall be properly vented before test is commenced.

G. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections.

H. Submit completed pipe pressure test log for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

3.8 GENERAL CONTRACTOR - MECHANICAL EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.
2. The plans indicate the location of all anticipated access panels. The Division 22 Contractor shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 22 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the mechanical and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.
   Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
2. The Division 22 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.
3. Division 22 Contractor is to notify the General Contractor prior to submitting his bid, the

number, size and location of all cutting and patching requirements. The Division 22 Contractor shall be liable for all associated costs of cutting and patching for mechanical work upon failure to notify the General Contractor prior to bid submission.

4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
8. **All penetrations through the walls, floor, or structure of laboratory spaces, laboratory support spaces, lecture halls, classrooms, conference rooms, corridors or other areas in which relative pressurization relationships are important shall be sealed airtight. Refer to the drawings for additional information regarding rooms in which maintaining pressurization is important.**
9. Repair cut surfaces to match adjacent surfaces.
10. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

    a. Uncover work to provide for installation of ill-timed work.
    b. Remove and replace defective work.
    c. Remove and replace work not conforming to requirements of the Contract Documents.
    d. Remove samples of installed Work as specified for testing.
    e. Install equipment and materials in existing structures.
    f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Excavation and Backfilling

1. Division 22 Contractor shall perform all excavation and backfilling necessary to install the required mechanical work. Coordinate the work with other excavating and backfilling work in the same area.
2. Except as indicated otherwise, comply with the applicable sections in Division 2 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
3. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work. All necessary shoring and bracing shall be installed to insure worker safety, proper installation of mechanical work, and protection of adjacent structures. Provide all dewatering as required. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only. All trenches shall be open cut from the surface.
4. Bedding: All work shall be properly bedded whether on virgin soil or on granular bedding as specified. All granular bedding shall be laid on undisturbed soil. PVC and copper piping shall have a 4" crushed stone bed conforming to specification for granular material in Division 2. If rock is encountered, excavate to a point 4" below installed bottom elevation of piping and provide bedding as called for above.
5. Haunching: Haunching shall be brought up on both sides of the pipe for a distance of 1/3 the pipe diameter and shall be of the same material used for bedding.
6. Backfill: Backfilling shall not begin until installation has been tested for leaks.
7. Final Backfill shall be as follows:

    a. Outside Building Under Paved Areas: Granular material specified in Division 2.

b. Outside Building and Not Under Paved Areas: Clean soil free of vegetable matter and foreign material or crushed limestone. In planted areas backfill to a point 6" below finished grade. Owner will provide topsoil to finished grade.

8. Placement: Place all granular material in lifts of 12" maximum compacted to 100% of maximum dry density as determined as ASTM D698. Place soil in 6" lifts compacted to 95% of maximum density as determined by ASTM D698. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.
9. Protection: At least 72 hours prior to excavating, for each phase, Contractor shall contact the Owner's Representative to arrange for utility locates in the construction area.
10. Contractor shall provide temporary supports for all underground utilities crossing an excavation.
11. Provide all required barricades, fencing, signs, lights, etc. as necessary for the protection of the workers and of the general public.
12. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site daily by the Contractor.
13. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Mechanical Contractor.

D. Concrete Bases

1. Minimum 4" high concrete housekeeping pads shall be provided under floor mounted mechanical equipment. Concrete inertia pads shall be provided for all base-mounted pumps and air compressors installed in the penthouse area.
2. Division 22 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all mechanical equipment bases. The Division 22 Contractor shall be liable for all associated costs to install the mechanical equipment bases upon failure to notify the General Contractor prior to bid submission.
   Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.

E. Roof curbs, roof support for mechanical equipment and roof penetrations.

1. Division 22 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 22 Contractor not shown on this plan. The General Contractor shall provide all roof deck mounted equipment and pipe supports, pipe penetrations and cut roof deck for pipe and duct penetrations, unless noted otherwise. The Division 22 Contractor shall furnish all roof curbs and the General Contractor shall install, unless noted otherwise. The Division 22 Contractor shall provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
2. The Division 22 Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
3. Division 22 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 22 Contractor not shown on this plan.

F. Painting

1. The General Contractor is to field paint mechanical equipment and materials in specified areas as noted on the mechanical plans, mechanical schedules and in the specifications. Division 22 Contractor is to coordinate the painting of these items with the General Contractor. The Mechanical Contractor is to provide materials in these areas that are suitable for accepting paint. The clean and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 22 Contractor.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 09 91 00.

3.9 ELECTRICAL-PLUMBING EXTENT OF WORK

A. The responsibility of work specified under Division 22 and 26 is clarified under, Section 22 05 13, "Electrical Requirements for Plumbing Equipment. Division 22 Contractor is to coordinate all electrical requirements prior to ordering powered plumbing equipment.

END OF SECTION 22 05 00

SECTION 22 05 13 - ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.2 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment. In addition, this section covers necessary coordination issues between plumbing and electrical disciplines. All plumbing and electrical construction documents must be completely reviewed by the Plumbing and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

1.3 REFERENCES

A. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:

1. ANSI/NEMA Standard MG 1: Motors and Generators
2. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
3. NEMA Standard 250: Enclosures for Electrical Equipment.
4. NEMA Standard KS 1: Enclosed Switches.
5. ANSI/NFPA 70 National Electrical Code.
6. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
7. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
8. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.

1.4 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

B. Reference Section 22 05 00

1.5 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled and listed.

2. PRODUCTS

SECTION 22 05 13 - ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

2.1 CONTRACTOR COORDINATION

A. It is the responsibility of the Contractor and all Subcontractors to coordinate scope to ensure that all required electrical connections and control connections are provided in accordance with all specification sections. The Architect/Engineer is not responsible for determining which Contractor or Subcontractor will provide particular items.

B. Unless otherwise indicated on drawings, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with this specification section and the following schedule. Attached notes shall apply to schedule.

ITEM:	FURNISHED BY:	SET BY:	POWER WIRING BY:	TEMPERATURE CONTROL WIRING BY:
Equipment motors	MC	MC	EC	TC
Motor control centers	EC	EC	EC	TC
Unit-mounted motor starters, contactors, and overload heaters	MC	MC	EC	TC
Loose single speed, full-voltage, non-reversing motor starters, disconnect switches, thermal overloads and heaters	EC	EC	EC	TC
Loose two speed or reduced voltage motor starters, disconnect switches, thermal overloads and heaters	MC	MC	EC	TC
Manual operating multi-speed switches	MC	EC	EC	TC
Control relays and transformers	TC	TC	EC	TC
Variable frequency drives	MC or TC	MC	EC	TC
Motors and solenoid valves, damper motors, PE and EP switches	TC	TC	TC	TC
Refrigeration equipment	MC	MC	EC	TC
Pushbutton stations and connections	EC	EC	EC	TC
Starters for control air compressors	TC	TC	EC	TC
Temporary Heating / Cooling	MC	MC	EC	TC

SECTION 22 05 13 - ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

ITEM:	FURNISHED BY:	SET BY:	POWER WIRING BY:	TEMPERATURE CONTROL WIRING BY:
Connections				
Thermostats, Time Switches	TC	TC	TC	TC
Temperature Control Panels	TC	TC	TC	TC

SCHEDULE KEY: MC = Plumbing Contractor
EC = Electrical Contractor
TC = Temperature Control Contractor

END OF SECTION 22 05 13

SECTION 22 05 29 – PLUMBING HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe and equipment hangers, supports, anchors, saddles and shields.

B. Equipment supports.

C. Equipment roof curbs.

D. Equipment roof supports.

E. Sleeves and seals.

F. Mechanical sleeve seals.

G. Flashing and sealing equipment and pipe stacks.

H. Sealants, firestop insulation, putty and compounds.

I. Mechanical seals.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and handling.

1.3 REFERENCES

A. ANSI/ASME B31.1 – Power Piping.

B. ANSI/AMSE B31.9 – Building Services Piping.

C. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture.

D. MSS SP-69 – Pipe Hangers and Supports – Selection and Application.

E. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.

1.4 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Delivery, storage and handling

D. Quality Assurance

2. PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Plumbing Piping:

1. Conform to International Plumbing Code, International Fuel Gas Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89 as applicable.

B. Pure Water Piping and Laboratory Waste and Vent Piping:

1. Conform to manufacturer's recommendations, MSS SP58, MSS SP69, MSS SP89, as applicable.

C. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

D. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

E. Hangers and Supports:

1. Hangers for Hot and Cold Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 Inches; Carbon steel, adjustable, clevis.
4. , cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

14. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
15. Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 22 07 19.
16. See Section 22 05 48 for vibration isolation hangers and supports.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength

2.8 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.9 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.10 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.11 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Metal Counterflashing: 22 gage galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb/sq ft sheet lead
2. Soundproofing: 1 lb/sq ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet buty; compatible with roofing.

E. Floor Drain and Floor Sink Flashing: 40 mil thick chlorinated polyethylene (CPE), equivalent to Chloraloy.

F. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.12 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.

C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.13 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

A. Firestopping Insulation: Glass fiber type, non-combustible, UL listed.

B. Firestop Putty: Non-harding, non shrinking, UL listed.

C. Firestop Compounds: Cementitous material, non-shrinking, UL listed.

D. Sealants:

1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

2.14 MECHANICAL SEALS

A. Mechanical Seals: Modular mechanical type, consisting of interlocking EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation. Provide Advance Products & Systems Model Innerlynx or equivalent.+

1. A sleeve shall be provided for each mechanical seal.

a. Thermoplastic sleeves: Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS or equivalent.
b. Steel sleeves: Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS or equivalent.

2. Provide high-temperature silicone links rated for 400 Deg. F for steam and condensate applications.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Reference applicable codes for maximum support spacing; see Section 22 0 500. Additional supports shall be provided at other locations as specified in this Section.

B. Reference applicable codes for maximum support spacing; see Section 22 0 500. Additional supports shall be provided at other locations as specified in this Section.

C. Support grooved pipe adjacent to each joint and at other locations per manufacturer recommendations.

D. Support piping adjacent to large pipe accessories such as valves, air separators, traps, etc. Provide additional supports as recommended by accessory manufacturer.

E. Independently support valves 16" and larger.

F. Install all hangers, supports, and accessories that shall be attached to structural steel prior to the application of structural steel fireproofing. Repair fireproofing if damaged during remainder of project.

G. Support horizontal piping as scheduled.

H. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Sprinkler Contractor.

I. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

J. Place hangers within 12 inches of each horizontal elbow.

K. Use hangers with 1-1/2 inch minimum vertical adjustment.

L. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

M. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

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

O. Support riser piping independently of connected horizontal piping.

P. Provide copper plated hangers and supports for non-insulated copper pipe.

Q. Design hangers for pipe movement without disengagement of supported pipe.

R. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

S. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

T. Space hangers for pure water and laboratory waste and vent systems to avoid pipe sags. Use manufacturer-recommended V-groove channel if necessary to maintain sag-free installation.

U. Saddles, Shields and Inserts

1. Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
2. Install protective shields MSS Type 40 on cold piping that has vapor barrier. Shields shall span an arc of 180 degrees (360 degrees on trapeze hangers with U-bolt clamps) and shall have dimensions in inches not less than the following:

NPS	LENGTH	THICKNESS
1 through 3-1/2	12	0.048
4	12	0.060
5 & 6	18	0.060
8 through 14	24	0.075
16 through 24	24	0.105

3. Pipes 8 inches and larger shall have wood inserts.
4. Insert materials shall be at least as long as the protective shield.
5. Provide manufacturer-recommended saddles, inserts, and/or shields where cellular foam insulation is used. The removal of sections of cellular foam insulation for the purpose of pipe support is not acceptable.

V. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

W. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

X. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

Y. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

Z. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

AA. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

BB. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

CC. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

DD. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

EE. Install lateral bracing with pipe hangers and supports to prevent swaying.

FF. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

GG. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

HH. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

II. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
    f. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
    g. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls and floors.

B. Flash floor drains in floors with topping over finished areas with CPE membrane, a minimum of 12 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

C. Seal floor, shower, mop sink, etc. drains watertight to adjacent materials.

D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe and duct sleeves are not required for penetrations through non-rated concealed partitions.

B. At the Contractor’s option, pipe sleeves may be omitted if the wall or floor is core drilled, except in areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.).

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Sleeves through floors shall be grinded flush with finish floor level. In areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.), sleeve shall extend a minimum of 2” above finish floor.

F. Where piping penetrates non-rated ceilings or walls, close off space between pipe or duct and adjacent work with urethane rod stock and caulk air tight.

G. Seal pipe penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.

H. Where piping penetrates rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.

I. Install chrome plated steel escutcheons on piping at finished surfaces.

J. Waste, vent and storm pipe penetrations through the concrete floor slab shall be encased in the poured concrete slab.

K. PVC pipe casing around the cold and hot water and gas piping shall be encased in poured concrete when penetrating the floor slab. Seal the opening between the piping and PVC casing with putty or rigid polyisocyanurate insulation plug and seal with caulking.

L. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

3.7 HANGER SPACING AND SIZE

A. Reference International Plumbing Code and International Fuel Gas Code where applicable.

B. Reference manufacturer's recommendations for pure water piping and laboratory waste and vent piping.

C. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

D. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

F. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

1. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Pipe Hangers

a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
b. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
c. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
d. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

e. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
f. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
g. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
h. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
i. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
j. Vee Bottom Clevis Hanger: For suspension of flexible plastic piping, Cooper B-Line B3106 or equivalent. Include plastic pipe support channel, Cooper B-Line B3106V.

2. Pipe Clamps

a. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
b. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
c. Wall or Ceiling Mounted Pipe Strap/Clamp (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

3. Pipe Supports

a. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
b. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
c. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
d. Pipe Rollers (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
e. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
f. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes. Shall only be connected to bottom joist chord if weight is 200 lbs or less.
6. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads. Shall only be connected to bottom joist chord if weight is 200 lbs or less.
7. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions. Shall only be connected to bottom joist chord if weight is 200 lbs or less.
8. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel. Shall only be connected to bottom joist chord if weight is 200 lbs or less.
9. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

10. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): For protection of pipe insulation; depth of saddle to be larger than insulation thickness. Fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections.

P. Comply with MFMA-103 for metal framing system selections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.8 MECHANICAL SEALS

A. Provide mechanical seals and sleeves through exterior wall and floor penetrations, and in 3-hour or higher fire rated partitions.

3.9 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.10 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.11 ADJUSTING

SECTION 22 05 29 – PLUMBING HANGERS AND SUPPORTS

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

END OF SECTION 22 05 29

SECTION 22 05 53 – PLUMBING IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe Markers.

D. Ceiling Tacks/Stickers.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Related Sections

C. Submittals

D. Quality Assurance

1.3 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700

B. Record actual locations of tagged valves.

2. PRODUCTS

2.1 NAMEPLATES

A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.

B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.

B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.

C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

A. Color: Conform to ASME A13.1.

B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service. Provide tape with printing which most accurately indicates the type of service of buried pipe.

2.4 CEILING TACKS/STICKERS

A. Description: ½" self adhesive color coded stickers.

B. Color code as follows:

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers, sprinkler/standpipe system valves
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

3. EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe and duct markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.

D. Identify air handling units, exhaust fans, chillers, pumps, heat generating, heat rejecting, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

E. Identify pressure reducing valves, backflow preventers, valves, and meters with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments, and relays. Key to control schematics.

I. Identify piping, concealed or exposed, with plastic tape pipe markers. For pipes ¾" and smaller, identify piping with tags. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locate identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or

enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

J. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

1. Provide 14 gauge electrical tracer wire above all underground pipe (plastic or other type of utility piping).

K. Provide ceiling stickers or machine generated labels to locate valves, dampers, or HVAC equipment above T-bar type panel ceilings. Locate ceiling sticker on the ceiling grid closest to equipment. Label each sticker with the device located above the ceiling, i.e. VBR-33.

END OF SECTION 22 05 53

SECTION 22 07 19 – PLUMBING PIPING INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Delivery, Storage and Handling

1.3 QUALITY ASSURANCE

A. See Section 22 05 00.

B. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, and UL 723.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.

1. 'K' ('ksi') value: ASTM C335, 0.24 at 75 degrees F.
2. Minimum Service Temperature: -20 degrees F.
3. Maximum Service Temperature: 300 degrees F
4. Maximum Moisture Absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket

1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Fibrous Glass Fabric: Cloth, untreated; 9 oz/sq yd weight with 1.0 lb/cu ft density blanket.

G. Indoor Vapor Barrier Finish: Vinyl emulsion type acrylic, compatible with insulation, white color.

2.2 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'K' ('ksi') Value: ASTM C177 or C518; 0.27 at 75 degrees F.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.3 “FIRE WRAP” INSULATION

A. 3M Fire Barrier Plenum Wrap 5A system.

1. System shall include all manufacturer-recommended sealants and accessories to provide full protection of enclosed piping.

2.4 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.

a. Minimum Service Temperature: -40 degrees F.
b. Maximum Service Temperature: 150 degrees F.
c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
d. Maximum Flame Spread: ASTM E84; 25.
e. Maximum Smoke Developed: ASTM E84; 50.
f. Thickness: 20 mil.
g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

2. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket: ASTM B209.

1. Thickness: 0.040 inch.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: PVC pre molded fittings.
5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

C. Stainless Steel Jacket: Type 304 or 316 stainless steel.

1. Thickness: 0.018 inch.
2. Finish: Smooth.

3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

3. EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. On exposed piping, locate insulation and cover seams in least visible locations.

C. Insulated pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, flanges, unions strainers, flexible connectors and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms.
3. Finish with glass cloth and vapor barrier adhesive.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. PVC covers are required in all exposed locations as in mechanical rooms.
3. Finish with glass cloth and adhesive.
4. For hot piping conveying fluids, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
5. For steam piping insulate flanges and unions at equipment.

E. Inserts and Shields:

1. Refer to Section 22 05 29 for additional information.
2. Application: Piping 1 inch diameter or larger.
3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
7. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such Armaflex Armafix Insulation Pipe Hangers, are acceptable.

F. Finish insulation at supports, protrusions, and interruptions.

G. For pipe exposed in finished spaces below 8 feet above finished floor, finish with PVC jacket and PVC fitting covers.

H. For piping exposed in mechanical rooms below 8 feet above finished floor, finish with aluminum jacket and aluminum fitting covers.

I. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

3.3 TOLERANCE

A. Substituted insulation materials, where allowed, shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 GLASS FIBER INSULATION SCHEDULE

A. Plumbing Systems

PIPING SYSTEM:	PIPE SIZE:	THICKNESS:
Cold Water	6” & smaller	1/2”
Domestic Hot Water and Recirc	1-1/4" & smaller	1"
Domestic Hot Water and Recirc	1-1/2" & larger	1-1/2"
Roof Drain Bodies	All sizes	1"
Roof Drainage Above Grade	All sizes	1"
Outside Air Plenum Drain Piping	All sizes	1/2"
Plumbing Vents Within 20 Feet of the Exterior	All sizes	1"
Fire Sprinkler System Main Drain and Inspector’s Test Valve Drain Within 20 Feet of Building Exterior	All sizes	1”

3.5 CELLULAR FOAM INSULATION SCHEDULE

A. Plumbing Systems

PIPING SYSTEM:	PIPE SIZE:	THICKNESS:
Refrigerant Piping	1-1/2” & smaller	1”
Refrigerant Piping	2” & larger	1-1/2”
Cold Condensate Drain Piping	6” & smaller	1”

END OF SECTION 22 07 19

SECTION 22 10 00 - PLUMBING PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Valves.

C. Sanitary waste and vent piping system.

D. Water piping systems.

E. Storm water piping system.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Valves: Manufacturer's name and pressure rating marked on valve body.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

1. Record actual locations of valves.

F. Delivery, storage, and handling

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

2. PRODUCTS

2.1 SANITARY WASTE AND VENT PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74, hub-and-spigot, service weight.

1. Fittings: Cast iron, ASTM A74, service weight.
2. Joints: ASTM C564 neoprene gasket system equivalent to Tyler Pipe Ty-Seal.

2.2 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A888 and CISPI 301, hubless, service weight for piping.

1. Fittings: Cast iron, ASTM A888 and CISPI 301, service weight.

2. Joints: Neoprene gaskets and heavy-duty stainless steel 4-band or 6-band clamp-and-shield assemblies.

2.3 WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
2. Joints: ASTM B32, lead-free solder, Grade 95TA, for piping 1-1/2" and smaller. AWS A5.8, BCuP silver braze, for piping 2" and larger.

Minimum 15% silver bearing filler material for copper-to-copper joints.
Minimum 45% silver bearing filler material for dissimilar metal joints.

2.4 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A888 and CISPI 301, hubless, service weight for piping.

1. Fittings: Cast iron, ASTM A888 and CISPI 301, service weight.
2. Joints: Neoprene gaskets and heavy duty stainless steel 4-band or 6-band clamp-and-shield assemblies.

2.5 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under:

1. Ferrous pipe: 150 psig malleable iron threaded unions.
2. Copper tube and pipe: 150 psig bronze unions with soldered joints.

B. Pipe Size Over 2 Inches:

1. Ferrous pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.
2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16 inch thick preformed neoprene gaskets.

C. Dielectric Connections: Where connecting ferrous and non-ferrous piping materials, use "ClearFlow" nipples to separate piping materials.

2.6 SWING CHECK VALVES

A. Up to and including 2 Inches: Bronze swing disc, 125 psig working pressure.

B. Over 2 Inches: Cast iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

2.7 BALL VALVES

A. Up to and including 4 inches: Bronze two piece body, chrome plated steel full-port ball, teflon seats and stuffing box ring, lever handle.

2.8 GATE VALVES

A. 3 Inches and larger: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged ends. Class 125, MSS SP-70.

B. Chainwheel: On valves 6" and larger and installed higher than 8-feet above finished floor, provide

sprocket rim, brackets, and chain compatible with valve.

2.9 STRAINERS

A. Size 2 inch and Under: Screwed bronze body for 250 psig working pressure, Y pattern with 20-mesh stainless steel perforated screen.

B. Size 2-1/2 inch and larger: Flanged cast iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.10 CALIBRATED BALANCE VALVES

A. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.

B. Valve Design and Construction. All valves shall have a calibrated orifice or venturi section, two ¼" threaded pressure tap ports with integral seals, and memory stop to retain the set position. Valves should be rated for 125 psig working pressure and 250 Deg. F maximum operating temperature.

C. Valves shall be selected based on flowrate, not on pipe size dimensions.

D. Preformed Insulation. All vales to be provided with molded insulation to permit access for balance and read-out.

2.11 DRAIN VALVES

A. Equipped with hose adaptor fitting and cap.

3. EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Vent pipes shall extend minimum 12” above finish roof line or as required by code.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access where valves and fittings are not exposed.

J. Establish elevations of buried sanitary and storm piping outside the building to ensure not less than 3 ft of cover.

K. Establish elevations of buried water piping outside the building to ensure not less than 5 ft of cover.

L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

M. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

P. Extend chains on valves with chainwheel operators down to maximum 5-feet above finished floor.

Q. Install strainers in horizontal pipe or in vertical pipe such that flow is downward. Do not install strainers in vertical pipe with flow upward.

R. Install cast iron piping system according to CISPI Handbook.

S. Install copper tubing under building slab according to CDA's "Copper Tube Handbook." Install ball valve directly upstream of each floor slab penetration.

T. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.

U. Install ball valve at all laboratory water connections to fume hoods and other laboratory equipment.

V. Install natural gas shutoff valves at each required piece of equipment. Provide gas regulators as necessary to accommodate equipment pressure requirements. Coordinate with equipment vendor.

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install valves for shut-off and to isolate equipment, part of systems, and vertical risers.

C. Install ball valves for throttling, bypass, or manual flow control services.

D. Provide spring loaded check valves on discharge of water pumps.

E. Provide plug valves in natural gas systems for shut-off service.

F. Provide flow control valves in water recirculating systems where indicated. Balance flow to maintain hot water at all plumbing fixtures.

3.5 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum or as indicated on drawings. Maintain gradients.

B. Slope water piping and arrange to drain at low points.

3.6 PLUMBING PIPING PRESSURE TESTING

A. Test for leaks and defects all new plumbing piping systems and parts of existing systems, which have been altered, extended or repaired. Submit copy of Pipe Pressure Test Log provided in section 22 05 00 for each section of piping tested. Refer to International Plumbing Code for general pipe pressure testing requirements (i.e., test pressure gauges, inspections, etc.).

B. Leave uncovered and unconcealed all new, altered, extended, or replaced piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

C. Repair all leaks and defects using new materials and retest all plumbing systems until satisfactory results are obtained.

3.7 DISINFECTION OF WATER PIPING SYSTEMS

A. After water systems have been pressure tested and flushed, each system (including distribution system to building) shall be cleaned and disinfected per AWWA C651. Note that procedures shall require two (2) consecutive sets of acceptable samples taken at least 24 hours apart.

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B. Take samples no sooner than 24 hours after flushing, from outlets and from water entry per AWWA 651, and analyze in accordance with AWWA C651.

C. Samples shall be subject to bacteriological testing by a recognized 3rd party testing agency. Send test reports to Owner for review. If unsatisfactory bacteriological results are found, the system shall be disinfected and retested again until satisfactory results are obtained.

3.8 SERVICE CONNECTIONS

A. Provide new sanitary and storm sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

END OF SECTION 22 10 00

SECTION 22 11 19 - PLUMBING SPECIALTIES

1. GENERAL

1.1 SECTION INCLUDES

A. Cleanouts.

B. Water hammer arresters.

C. Installation requirements of other plumbing specialties scheduled in Plumbing Fixture Schedule.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

F. Delivery, storage, and handling

2. PRODUCTS

2.1 CLEANOUTS

A. Exterior Surfaced Areas: Round or Square cast nickel bronze access frame and non-skid cover.

B. Interior Finished Floor Areas: cast iron body and frame, nickel bronze top to accommodate the following floor finishes as required:

1. Exposed rim type with recess to receive tarrazzo or resilient floor finish.
2. Exposed finish type with standard mill finish.
3. Exposed flush type with standard scored or abrasive finish.
4. Concealed undercarpet flush type with mill finish and carpet marker.

C. Interior Finished Wall Areas: Line type with cast iron body and round gasket cover and round stainless steel access cover secured with machine screw.

D. Interior Unfinished Accessible Areas: Caulked or threaded type.

2.2 WATER HAMMER ARRESTERS

A. Standard: ASSE 1010 or PDI-WH 201.

B. Type: Josam 75000 Series water hammer arresters or equal.

C. Size: Size per manufacturer recommendations.

2.3 OTHER SPECIALTIES

A. Refer to Plumbing Fixture Schedule for required product information.

3. EXECUTION

3.1 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Install water hammer arrestors complete with accessible isolation valve according to PDI-WH 201 and as shown on drawings.

3.3 TESTING

A. Test and certify all backflow preventers for proper operation. Testing agent shall be Grade VI Water Operator.

1. Test shall be completed within 30 days of installation or Substantial Completion, whichever is later.

END OF SECTION 22 11 19

SECTION 22 40 00 - PLUMBING FIXTURES

1. GENERAL

1.1 SECTION INCLUDES

A. Installation requirements of plumbing fixtures scheduled in Plumbing Fixture Schedule.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Quality Assurance

D. Delivery, Storage and Handling

1.3 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

2. PRODUCTS

2.1 PLUMBING FIXTURES

A. Refer to Plumbing Fixture Schedule for all required product information.

B. The Contractor is responsible for ensuring that all roof drains are compatible with roof types and roof insulation. Refer to architectural and structural plans for roof information. No additional compensation will be allowed for failure to coordinate roof drains with roof types.

3. EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install each fixture with trap with 2 slip joints, easily removable for servicing and cleaning.

C. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with scheduled wall supports or wall carriers and bolts.

F. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.

3.4 LAVATORY AND SINK INSTALLATION

A. Install lavatories and sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories and sinks.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1. Coordinate exact locations with drawings.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

E. Seal joints between lavatories/sinks, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks.

G. Install water-supply piping with stop on each supply to each faucet.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with lavatory/sink.
2. Install stops in locations where they can be easily reached for operation.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.6 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

C. Adjust water pressure at flushometer valves to produce proper flow.

D. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.7 CLEANING

A. Directly prior to project turnover, clean plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets, urinals, and fittings.

C. Do not allow use of plumbing fixtures for use during construction unless approved in writing by Owner.

SECTION 22 40 00 - PLUMBING FIXTURES

END OF SECTION 22 40 00

SECTION 23 05 00 - BASIC HVAC REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

A. This section describes Basic Mechanical Requirements required to provide for a complete installation of all mechanical systems for this project. This section shall apply to all other Division 23 specification sections as well as all work shown on the drawings.

B. Mechanical demolition requirements (if any).

C. It is the intent of the Mechanical Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.

D. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative.

E. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.

F. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

G. Note that the words "mechanical" and "plumbing" are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 23.

1.3 DESCRIPTION OF WORK

A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete mechanical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping fixtures, etc. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

1.4 PERMITS

A. All permits, fees, licenses, etc. required for this project shall be obtained by the Contractor.

1.5 QUALITY ASSURANCE

A. Installers shall have at least 2 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for

satisfactory operation, unless noted otherwise in other mechanical sections.

B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.

C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.

F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.

G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.6 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
3. ABMA - American Boiler Manufacturers Association.
4. ACCA - Air Conditioning Contractors of America.
5. ACGIH - American Conference of Governmental Industrial Hygienists.
6. ADC - Air Diffusion Council.
7. AGA - American Gas Association.
8. AIHA - American Industrial Hygiene Association.
9. AMCA - Air Movement and Control Association.
10. ANSI - American National Standards Institute.
11. ARI - Air-Conditioning and Refrigeration Institute.
12. ASA - Acoustical Society of American.
13. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
14. ASME - The American Society of Mechanical Engineers.
15. ASTM - American Society of Testing and Materials.
16. CAGI - Compressed Air and Gas Institute.
17. CTI - Cooling Tower Institute.
18. EJMA - Expansion Joint Manufacturers Association.
19. ETL - Engineering Tests Laboratory.
20. HEI - Heat Exchange Institute.
21. HI - Hydraulic Institute.
22. HYD I - Hydronics Institute.
23. ICBO - International Conference of Building Officials.
24. ICC – International Code Council.
25. NEBB - National Environmental Balancing Bureau.
26. NEC - National Electrical Code.

27. NEMA - National Electrical Manufacturers Association.
28. NFPA - National Fire Protection Association.
29. NSF - National Sanitation Foundation.
30. SAE - Society of Automatic Engineers.
31. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
32. TEMA - Tubular Exchanger Manufacturers Association.
33. UL - Underwriters Laboratories, Inc.
34. International Plumbing Code.
35. International Mechanical Code.
36. Other governing, state, and local codes that apply.

1.7 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and “Special Conditions”.

B. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Mechanical Sections.

1. Certified performance and data with system operating conditions indicated (winter and summer performance as necessary). All coil, fan, and pump performance data shall be computer generated.

   a. Submit sound power level data for all inlets, outlets, and casing radiation at rated capacities for all air handling equipment. Provide calculated sound power data based on AMCA 320 sound intensity test methods.
   b. Where filters are included with equipment, provide data of filter media, filter performance data, filter assembly, and filter frames.

2. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
3. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, gages and finishes of materials, and methods of assembly of components.
4. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Maintenance Data: Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

C. Provide separate shop drawing submittals for the following items.:

1. Section 23 05 00:

Submittal Requirement:	**Date Submitted:**
Mechanical permits	
EPA/ASHRAE 34 refrigeration certification	
Welding certificates	

Submittal Requirement:	**Date Submitted:**
Warranties	
As-built documents	
Pipe pressure test logs	
Operation and maintenance manuals (electronic copies integrated into EMCS)	
Close-out / walk-through documentation	
Training seminar documentation	

2. Section 23 05 19:

Submittal Requirement:	**Date Submitted:**
Flow meters	
Calibrated balance valves	
Pressure gauges	
Thermometers	
Pressure/temperature test plugs	
Duct static pressure gauges	

3. Section 23 05 29:

Submittal Requirement:	**Date Submitted:**
Pipe supports, anchors, sleeves, and hangers	
Equipment curbs, supports, and hangers	
Mechanical seals	
Roof curbs and supports	
Fire sealants	

4. Section 23 05 48:

Submittal Requirement:	**Date Submitted:**
Vibrations controls	

5. Section 23 05 53:

Submittal Requirement:	**Date Submitted:**
Mechanical identification materials	

Submittal Requirement:	**Date Submitted:**
Valve schedule	

6. Section 23 05 93:

Submittal Requirement:	**Date Submitted:**
Agency compliance documentation	
Pre-balancing conference meeting documentation	
Pre-balancing field deficiency report(s)	
Draft TAB report	
Final TAB report	

7. Section 23 07 13:

Submittal Requirement:	**Date Submitted:**
Ductwork insulation materials and insulation schedule	

8. Section 22 07 16:

Submittal Requirement:	**Date Submitted:**
Equipment insulation materials and insulation schedule	

9. Section 22 07 19:

Submittal Requirement:	**Date Submitted:**
Pipe insulation materials and insulation schedule	

10. Section 23 09 00, 23 09 01 & 23 09 93:

Submittal Requirement:	**Date Submitted:**
Control drawings	
Control materials and equipment	
Sequences of operation	
Points list	

11. Section 23 09 02:

Submittal Requirement:	**Date Submitted:**
Variable frequency drives	
Factory start-up report(s)	

12. Section 23 21 13:

Submittal Requirement:	**Date Submitted:**
HVAC piping material and fitting schedule	
HVAC valves	
HVAC pipe accessories	
HVAC hydrostatic test report(s)	

13. Section 23 21 16:

Submittal Requirement:	**Date Submitted:**
HVAC specialty equipment and materials	
Strainers	
Air vents	
Pump suction fittings	
Combination pump discharge valves	
Relief valves	
Flexible connections	
Glycol specialties	

14. Section 23 21 23:

Submittal Requirement:	**Date Submitted:**
HVAC pumps	

15. Section 23 22 13:

Submittal Requirement:	**Date Submitted:**
Steam and condensate piping material and fitting schedule	
Steam and condensate valves	
Steam and condensate hydrostatic test report(s)	

16. Section 23 22 14:

Submittal Requirement:	**Date Submitted:**
Steam and condensate specialties	

17. Section 23 25 00:

Submittal Requirement:	**Date Submitted:**
Chemical feeder equipment	

Submittal Requirement:	**Date Submitted:**
Chemical treatment materials	
Chemical material safety data sheet (MSDS) information	
Monthly field inspection reports	

18. Section 23 31 13:

Submittal Requirement:	**Date Submitted:**
Ductwork material and schedule	
Flexible ductwork	
High pressure manufactured ductwork fittings	
Low pressure manufactured ductwork fittings	
Ductwork hangers, sealants, tapes, etc.	
Ductwork connection systems	
Owner approval of ductwork cleaning	
Fire, smoke, and fire/smoke damper resetting demonstration documentation	
Ductwork coordination drawings	

19. Section 23 33 00:

Submittal Requirement:	**Date Submitted:**
Dampers	
Flexible duct connections	
Duct access doors	
Duct test hole plugs	
Volume control dampers	
Damper quadrants	

20. Section 23 34 13:

Submittal Requirement:	**Date Submitted:**
Mixed flow fans	

21. Section 23 36 00:

Submittal Requirement:	**Date Submitted:**

Submittal Requirement:	**Date Submitted:**
Air terminal units and accessories	

22. Section 23 37 00:

Submittal Requirement:	**Date Submitted:**
Air outlets and inlets	

23. Section 23 73 13:

Submittal Requirement:	**Date Submitted:**
Air handling units	

24. Section 23 95 00:

Submittal Requirement:	**Date Submitted:**
Mechanical commissioning documentation	

25. Section 23 99 50:

Submittal Requirement:	**Date Submitted:**
Building automation system commissioning documentation	

1.8 SUBSTITUTES

A. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified.

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing. Associated mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are to be increased accordingly, but all recommended manufacturer clearances, etc., are to be maintained within the allotted mechanical spaces. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

C. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.

D. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.

E. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.

F. Final determination regarding substitutions shall be by the Architect/Engineer.

1.9 WARRANTY

A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Mechanical Sections.

1.10 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.

C. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.

D. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.

E. All tests shall be made after notification to and in the presence of the Owner's representative.

F. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.

G. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.

H. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.

I. At the time of substantial project completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.11 RECORD DOCUMENTS

A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:

1. The Mechanical Contractor shall provide the Owner with as-built drawings for ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units and indicate all devices requiring periodic maintenance or repair, such as control power transformers, LACS panels/routers, field controllers, duct static pressure sensors, piping pressure sensors, etc.
2. All mechanical systems as described in the Specifications and/or shown on the drawings.

3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.
4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.

1.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

B. Provide electronic copies, preferably in Adobe Acrobat Portable Document Format (pdf), of all maintenance manuals to Temperature Control Contractor for use in EMCS front-end system. Provide data in file types compatible with EMCS.

2. PRODUCTS (NOT APPLICABLE).

3. EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 01 Sections for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components specified under Division 23 and as indicated on the drawings.

1. Controls
2. Demolition related to others areas that must remain on line.
3. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
4. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
5. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
6. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
7. Equipment to Be Removed: Disconnect and cap services and remove equipment.
8. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
9. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality. Refer to insulation specifications…..

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Use proper lifting equipment where size/weight requires handling by such means.

D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.

E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.

F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

G. Mechanical Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

3.3 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.4 COORDINATION

A. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Coordinate the mechanical work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
3. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.5 MECHANICAL INSTALLATIONS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner's representative shall be notified and any changes approved before proceeding with the work.

D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

I. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

K. Welding, sweating, or brazing operations

1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials can not be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.
4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult

with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.6 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.7 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.8 START-UP

3.9 PIPING SYSTEMS PRESSURE TESTING

A. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:

1. UNL Project Inspector

B. Removal of pressure charge and associated drain down shall also be witnessed.

C. Mechanical contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.

D. Pressure gauge requirements: Provide recently calibrated gauge with 4" face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.

E. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.

F. Entire system shall be properly vented before test is commenced.

G. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections.

H. Submit completed pipe pressure test log for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

3.10 GENERAL CONTRACTOR - MECHANICAL EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.
2. The plans indicate the location of all anticipated access panels. The Division 23 Contractor

shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 23 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the mechanical and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.

3. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

2. The Division 23 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.
3. Division 23 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all cutting and patching requirements. The Division 23 Contractor shall be liable for all associated costs of cutting and patching for mechanical work upon failure to notify the General Contractor prior to bid submission.
4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
8. All penetrations through the walls, floor, or structure of laboratory spaces, laboratory support spaces, lecture halls, classrooms, conference rooms, corridors or other areas in which relative pressurization relationships are important shall be sealed airtight. Refer to the drawings for additional information regarding rooms in which maintaining pressurization is important.
9. Repair cut surfaces to match adjacent surfaces.
10. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

    a. Uncover work to provide for installation of ill-timed work.
    b. Remove and replace defective work.
    c. Remove and replace work not conforming to requirements of the Contract Documents.
    d. Remove samples of installed Work as specified for testing.
    e. Install equipment and materials in existing structures.
    f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Concrete Bases

1. Minimum 4" high concrete housekeeping pads shall be provided under floor mounted mechanical equipment. Concrete inertia pads shall be provided for all base-mounted pumps and air compressors installed in the penthouse area.
2. Division 23 Contractor is to notify the General Contractor prior to submitting his bid, the

number, size and location of all mechanical equipment bases. The Division 23 Contractor shall be liable for all associated costs to install the mechanical equipment bases upon failure to notify the General Contractor prior to bid submission.

3. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.

D. Roof curbs, roof support for mechanical equipment and roof penetrations.

1. Division 23 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 23 Contractor not shown on this plan. The General Contractor shall provide all roof deck mounted equipment and pipe supports, pipe penetrations and cut roof deck for pipe and duct penetrations, unless noted otherwise. The Division 23 Contractor shall furnish all roof curbs and the General Contractor shall install, unless noted otherwise. The Division 23 Contractor shall provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
2. The Division 23 Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
3. Division 23 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 23 Contractor not shown on this plan.

E. Painting

1. The General Contractor is to field paint mechanical equipment and materials in specified areas as noted on the mechanical plans, mechanical schedules and in the specifications. Division 23 Contractor is to coordinate the painting of these items with the General Contractor. The Mechanical Contractor is to provide materials in these areas that are suitable for accepting paint. The clean and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 23 Contractor.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 09 91 00.

3.11 ELECTRICAL-MECHANICAL EXTENT OF WORK

A. The responsibility of work specified under Division 23 and 26 is clarified under, Section 23 05 13, "Electrical Requirements for Mechanical Equipment. Division 23 Contractor is to coordinate all electrical requirements prior to ordering powered mechanical equipment.

ND OF SECTION 23 05 00

SECTION 23 05 13 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Electrical Requirements for:

1. Motors
2. Starters, Electrical Devices, and Wiring
3. Manual Motor Starters
4. Motor Connections
5. Capacitors
6. Safety Switches

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Electrical components and materials shall be UL labeled and listed.

B. References.

1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:

a. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
b. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
c. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
d. ANSI/NEMA Standard MG 1 – Motors and Generators.
e. ANSI/NFPA 70 - National Electrical Code.
f. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
g. NEMA Standard 250 – Enclosures for Electrical Equipment.
h. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.

1. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and holding

G. Related sections.

1. Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.3 SUMMARY

SECTION 23 05 13 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment. In addition, this section covers necessary coordination issues between mechanical and electrical disciplines. All mechanical and electrical construction documents must be completely reviewed by the Mechanical and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

2. PRODUCTS

2.1 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Minimum service factors shall be as follows:

Motor Service Factor Schedule		
Horsepower:	**3600 RPM:**	**1800 RPM:**
1/6 – 1/3	1.35	1.35
1/2	1.25	1.25
3/4	1.25	1.25
1 – 1.25	1.25	1.15
1.5 - 150	1.15	1.15

3. Two-speed poly-phase motors shall have two separate windings served by a single point electrical connection to the two speed starter. Two speed starters shall be located at the motor location unless otherwise noted.
4. Temperature Rating: Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
5. Starting capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly timed starts per hour for manually controlled motors.
6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.

    a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit each specific application.
    b. Bearings: Ball or roller bearings with inner and outer shaft seals; re-greasable; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
    c. Enclosure Type: Unless otherwise noted, use open drip-proof motors where satisfactorily housed or remotely located during operation; guarded drip-proof motors

where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.

d. Overload protection: Built-in thermal overload protection (in accordance with NEC requirements) and, where indicated, an internal sensing device suitable for signaling and stopping the motor at the starter.

7. Noise rating: "Quiet"
8. Efficiency: **"Premium efficiency"** motors, as defined in NEMA MG 1, most recent edition.
9. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
10. All three-phase motors shall be inverter duty type.
11. Motors Used With Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motor shall be designed and labeled for use with variable frequency drives. Motor shall be designed with critical vibration frequencies outside the operating range of the drive output and shall be suitable for use throughout speed range without overheating.

    a. All motors served by VFD's must have factory installed current insulated bearings or shaft grounding assemblies such as the Helwig brand carbon brush. Carbon fiber brush rings (i.e. Aegis brand shaft grounding kits) shall not be allowed.

12. Motors Used for Wet or Corrosive Duty: Severe duty with cast-iron frame, epoxy finish, stainless steel nameplate, polymer shaft seal, corrosion-resistant fasteners and fan, moisture-resistant windings, and non-wicking leads.

2.2 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor shall be responsible for replacement sheaves required to achieve specified performance. Coordinate with testing and balancing of the equipment.

2.3 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor-Starter Characteristics: Motor starters shall be compatible with the equipment they serve. In general, motor starter characteristics shall meet the requirements of Division 26 specification sections and as outlined as follows:

B. Motor Connections

1. Provide connections to motors in accordance with the requirements listed in the electrical specifications.
2. See Division 26 for the use of lugs for motor connections.

C. Capacitors

1. Capacitor features shall include:

    a. Individual unit cells.
    b. All welded steel housing.

c. Each capacitor shall be internally fused.
d. Non-flammable synthetic liquid impregnate.
e. Craft tissue insulation.
f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

D. FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

E. FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

F. MANUAL MOTOR STARTERS

G. See specification section 26 29 13 – Motor Controllers for requirements.

H. CAPACITORS

1. Capacitor features shall include:

a. Individual unit cells.
b. All welded steel housing.
c. Each capacitor shall be internally fused.
d. Non-flammable synthetic liquid impregnate.
e. Craft tissue insulation.
f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

2.4 SAFETY SWITCHES

A. See specification section 26 05 01 – Basic Electrical Materials and Methods.

3. EXECUTION

3.1 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

3.2 CONTRACTOR COORDINATION

A. General contractor is responsible for coordination of all subcontractors and associated scopes of work.

B. Unless otherwise indicated on drawings, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with this specification section and the following schedule. Attached notes shall apply to schedule.

ITEM:	FURNISHED BY:	SET BY:	POWER WIRING BY:	TEMPERATURE CONTROL WIRING BY:
Equipment motors	MC	MC	EC	TC
Motor control centers	EC	EC	EC	TC
Unit-mounted motor starters, contactors, and overload heaters	MC	MC	EC	TC
Loose single speed, full-voltage, non-reversing motor starters, disconnect switches, thermal overloads and heaters	EC	EC	EC	TC
Loose two speed or reduced voltage motor starters, disconnect switches, thermal overloads and heaters	MC	MC	EC	TC
Manual operating multi-speed switches	MC	EC	EC	TC
Control relays and transformers	TC	TC	EC	TC
Control relays and transformers for LACS system	LACS	LACS	EC	TC
Thermostats and time switches	TC	TC	TC	TC
Temperature control panels	TC	TC	TC	TC
Variable frequency drives	MC or TC	MC	EC	TC

ITEM:	FURNISHED BY:	SET BY:	POWER WIRING BY:	TEMPERATURE CONTROL WIRING BY:
Motors and solenoid valves, damper motors, PE and EP switches	TC	TC	TC	TC
Refrigeration equipment	MC	MC	EC	TC
Pushbutton stations and connections	EC	EC	EC	TC
Temporary heating/cooling connections	MC	MC	EC	TC
Starters for control air compressors	TC	TC	EC	TC

SCHEDULE KEY: MC = Mechanical Contractor
EC = Electrical Contractor
TC = Temperature Control Contractor
LACS = Laboratory Airflow Control System Supplier

COORDINATION OF RESPONSIBILITIES FOR MECHANICAL, ELECTRICAL AND UNL FURNISHED SYSTEMS	NOTES: GC = GENERAL CONTRACTOR MC = MECHANICAL CONTRACTOR EC = ELECTRICAL CONTRACTOR BSM CG = UNL BUIDING SYSTEMS MANAGEMENT CONTROL GROUP UNL UTIL = UNIV OF NEBR-LINCOLN UTILITIES			
ITEM	FURNISHED BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment Motors	MC	MC	EC	BSM CG
Motor Control Centers	EC	EC	EC	BSM CG
Unit Mounted Motor Starters, Contactors, Disconnect Switches, Thermal Overloads and Heaters	MC	MC	EC	BSM CG
Loose Motor Starters, Contactors, Disconnect Switches, Thermal Overloads and Heaters	EC	EC	EC	BSM CG
Pushbutton Stations and Safety Stop Switches – Air Handling Systems and Hydronic Systems	EC	EC	NA	BSM CG
Variable Speed Drives and Associated Safety Disconnects	BSM CG	EC	EC	BSM CG
Temporary Heating/Cooling and Connections	GC	MC/EC	EC	MC/EC
Chiller and Boiler Controls	MC	MC	EC	MC
Computer Room Air Conditioning Systems	MC	MC	EC	MC
Lab Ventilation Control Systems Air Valves	MC	MC	NA	NA
Lab Ventilation Control Systems Controls	BSM CG	BSM CG	BSM CG	BSM CG
Control Systems Compressed Air High Pressure Main Riser	MC	MC	NA	NA
Control Systems PRV Stations	BSM CG	MC	NA	BSM CG
Control Systems Compressed Air Mains 20PSI	BSM CG	BSM CG	NA	NA

SECTION 23 05 13 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

COORDINATION OF RESPONSIBILITIES FOR MECHANICAL, ELECTRICAL AND UNL FURNISHED SYSTEMS	NOTES: GC = GENERAL CONTRACTOR MC = MECHANICAL CONTRACTOR EC = ELECTRICAL CONTRACTOR BSM CG = UNL BUIDING SYSTEMS MANAGEMENT CONTROL GROUP UNL UTIL = UNIV OF NEBR-LINCOLN UTILITIES			
ITEM	FURNISHED BY	SET BY	POWER WIRING	CONTROL WIRING
Thermostats And Terminal Controls – Line Voltage	BSM CG	EC	EC	EC
Room Controls Transformer Panels	BSM CG	EC	EC	BSM CG
Thermostats And Terminal Unit Controls – Low Voltage	BSM CG	BSM CG	BSM CG	BSM CG
Air Terminal Units And Hydronic Reheat Coils	MC	MC	EC	NA
Air Terminal Units And Electric Reheat Coils	MC	MC	EC	NA
Automatic Flow Control Devices	MC	MC	NA	NA
System Controls Temperature Control Panels	BSM CG	BSM CG	EC	BSM CG
Air Handling And Hydronic Systems Controls	BSM CG	BSM CG	NA	BSM CG
Air Handling Systems Pressure Sensors	BSM CG	BSM CG	NA	BSM CG
Automatic Control Damper Actuators	BSM CG	BSM CG	NA	BSM CG
Automatic Control Dampers	BSM CG	MC	NA	BSM CG
Smoke/Fire Dampers	MC	MC	EC	BSM CG
Automatic Control Valves And Actuators	BSM CG	MC	NA	BSM CG
Air Handling Systems Air Flow Stations	BSM CG	BSM CG	NA	BSM CG
Hydronic Systems Temperature Sensor Wells	BSM CG	MC	NA	BSM CG
Hydronic And Steam Systems Pressure Taps	MC	MC	NA	NA
Hydronic And Steam Systems Pressure Sensors	BSM CG	MC	NA	BSM CG
Chilled Water Btu Meters	BSM CG	MC	EC	BSM CG
Heating Water Flow Meters	BSM CG	MC	NA	BSM CG
Steam Condensate Meters	BSM CG	MC	EC	BSM CG
Steam Condensate Level Alarm	MC	MC	NA	BSM CG
Card Access Bldg Controllers	BSM CG	BSM CG	EC	BSM CG
Card Access Network Connections	GC	GC	NA	NA
Card Access Door Controllers	BSM CG	BSM CG	EC	BSM CG
Card Access Door Hardware	GC	GC	EC	BSM CG
Card Access Handicap Door Hardware	GC	GC	EC	BSM CG
Handicap Door Hardware (No Card Access)	GC	GC	EC	EC
Video Surveillance Bldg Computers	BSM CG	BSM CG	EC	BSM CG
Video Surveillance Network Connections	NA	NA	NA	NA
Video Surveillance Cameras	BSM CG	BSM CG	EC	BSM CG
Video Surveillance Circuits	BSM CG	BSM CG	EC	BSM CG
Security Systems Building Controllers	BSM CG	BSM CG	EC	BSM CG
Security Systems Communications Circuits	NA	NA	EC	BSM CG
Security Systems Field Devices	BSM CG	BSM CG	EC	BSM CG
Fire Alarm Panels	BSM CG	BSM CG	EC	BSM CG
Fire Alarm Communications Circuits	NA	NA	NA	NA

END OF SECTION 23 05 13

SECTION 23 05 19 – HVAC METERS AND GAGES

1. GENERAL

1.1 SECTION INCLUDES

A. Sight flow indicators.

B. Pressure gages and pressure gage taps.

C. Thermometers and thermometer wells.

D. Piping pressure and temperature test plugs.

E. Static pressure and filter gages.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

1. Accurately record actual locations of instrumentation.

F. Delivery, storage, and handling

1.3 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

2. PRODUCTS

2.1 SIGHT FLOW INDICATORS

A. Bronze or stainless-steel body, with sight glass and paddle wheel indicator, threaded or flanged ends.

B. Minimum pressure rating: 150 psig.

C. Minimum temperature rating: 200 deg F.

D. End connections for NPS 2 inch and smaller: Threaded.

E. End Connections for NPS 2-1/2 inch and larger: Flanged.

2.2 PRESSURE GAGES

A. Standard: ASME B40.200.

B. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.

C. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

D. Connector: Brass, 1/4-inch NPS.

E. Scale: White coated aluminum, with permanently etched markings.

F. Accuracy: Plus or minus 1 percent of range span.

G. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.3 PRESSURE GAGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.4 GLASS THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red reading, magnifying lens, with non-mercury fluid.

E. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

F. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

G. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

H. Scale range: Temperature ranges for services listed as follows:

1. Condenser/Heat Pump Water: 0 to 160 deg F with 2-degree scale divisions (minus 18 to 70 deg C with 1-degree scale divisions).
2. Heating Water: 30 to 250 deg with 2-degree scale divisions (0 to 150 deg C with 1-degree scale divisions).
3. Chilled Water: 0 to 100 deg F with 2-degree scale divisions (minus 20 to 50 deg C with 1-degree scale divisions).
4. Steam and Condensate: 50 to 400 deg F with 2-degree scale divisions (0 to 200 deg C with 1-degree scale divisions).

2.5 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.6 PIPING PRESSURE AND TEMPERATURE TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:

1. Air, Water, Oil, and Gas, 20 to 200 deg F (minus 7 to 93 deg C): Neoprene.

2.7 STATIC PRESSURE GAGES

A. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch (6 mm) diameter tubing.

C. Construction: Bronze or stainless-steel body, with sight glass and [ball, flapper, or paddle wheel] <Insert device> indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: [125 psig (860 kPa)] [150 psig (1034 kPa)] <Insert value>.

E. Minimum Temperature Rating: [200 deg F (93 deg C)] <Insert temperature>.

F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 FLOW MEASURING METERS

A. Install where shown on plans and schematics as indicated.

B. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions and as detailed on drawings.

C. Install flowmeter elements in accessible positions in piping systems. Maintain manufacturer-recommended minimum upstream and downstream distances.

D. Install permanent indicators on walls or brackets in accessible and readable positions.

E. Install connection fittings in accessible locations for attachment to portable indicators.

F. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

G. Install flow meters for piping systems located in accessible locations at most readable position.

H. Calibrate meter after installation in accordance with manufacturer's installation instructions.

I. Installation of steam meter and associated wiring, pressure transmitter and RTD assembly, shall be in strict accordance with manufacturer's printed instructions and recommendations, applicable BOCA requirements, and as detailed on drawings.

J. Pressure and temperature taps shall be installed a minimum of three pipe diameters downstream, before any isolation valves.

K. Steam will not be turned on by UNL personnel until the steam meter is fully installed and operating satisfactorily and the downstream steam piping is successfully leak tested and secure.

L. Only UNL personnel will be authorized to turn steam service on or off.

3.3 PRESSURE GAGES

A. Install pressure gages in piping tee with pressure gage valve, located on pipe at most readable position.

B. Install as shown on plans, and elsewhere as indicated.

C. Pressure Gage Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.4 THERMOMETERS

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install as shown on plans and elsewhere as indicated.

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.5 TEST PLUGS

A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION 23 05 19

SECTION 23 05 29 – HVAC HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe, ductwork, and equipment hangers, supports, anchors, saddles and shields.

B. Mechanical flashing.

C. Equipment curbs.

D. Mechanical sleeves and seals.

E. Flashing and sealing equipment and pipe stacks.

F. Sealants, firestop insulation, putty and compounds.

G. Pipe Stands

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and handling.

2. PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Hydronic Piping:

1. Conform to International Mechanical Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89 as applicable.

B. Steam and Steam Condensate Piping:

1. Conform to International Mechanical Code, ASME B31.1, ASTM F708, MSS SP58, MSS SP69, MSS SP89, as applicable.

C. Refrigerant Piping

1. Conform to International Mechanical Code, ASME B31.1, ASTM F708, MSS SP58, MSS SP69, MSS SP89, as applicable.

D. Hangers and Supports:

1. Hangers for Hot and Cold Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 Inches; Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
14. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
15. Roof Support for Hot and Cold Pipe: See PIPE STANDS section below.
16. Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 23 07 19.
17. See Section 23 05 48 for vibration isolation hangers and supports if applicable.

2.2 DUCTWORK HANGERS AND SUPPORTS

A. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

B. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

C. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Exposed Stainless-Steel Ducts: Stainless-steel shapes and plates.

2.3 ACCESSORIES

A. Hanger Rods: ASTM A36 steel or galvanized threaded both ends, threaded one end, or continuous threaded.

1. Ductwork: Use double nuts and lock washers on threaded rod supports.

2.4 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Metal Counterflashing: 22 gage galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb/sq ft sheet lead
2. Soundproofing: 1 lb/sq ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet buty; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.6 EQUIPMENT CURBS

A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, 1-1/2 inch thick insulation, factory installed wood nailer. Minimum 18 inch height, unless specified otherwise.

2.7 SLEEVES

A. Sleeves for Pipes through Fire Rated Floors and Walls: Schedule 40 steel pipe.

B. Sleeves for Pipes Through Non-fire Rated Floors and Walls: 18 gage galvanized steel.

C. Sleeves for Ductwork: Galvanized steel.

2.8 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

A. Firestopping Insulation: Glass fiber type, non-combustible, UL listed.

B. Firestop Putty: Non-harding, non shrinking, UL listed.

C. Firestop Compounds: Cementitous material, non-shrinking, UL listed.

D. Sealants:

1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

2.9 MECHANICAL SEALS

A. Mechanical Seals: Modular mechanical type, consisting of interlocking EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation.

1. Provide high-temperature silicone links rated for 400 Deg. F for steam and condensate applications.

2. A sleeve shall be provided for each mechanical seal.

   a. Thermoplastic sleeves: Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS or equivalent.
   b. Steel sleeves: Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS or equivalent.

2.10 PIPE STANDS (ROOF)

A. General Requirements for Pipe Stands: Shop or field –fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel with plastic or stainless-steel, roller-type pipe support.

D. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of Bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal member: Protective-coated-steel channel.
5. Pipe Supports: galvanized-steel, clevis-type pipe hangers.

E. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Sprinkler Contractor.

1. Reference sections 21 05 29 and 22 05 29 for additional information regarding fire protection and plumbing piping supports and hangers.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor and at intervals of no more than 12 ft. Support vertical cast iron pipe at each floor at hub.

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

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for non-insulated copper pipe.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

N. Saddles, Shields and Inserts

1. Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
2. Install protective shields MSS Type 40 on cold piping that has vapor barrier. Shields shall span an arc of 180 degrees (360 degrees on trapeze hangers with U-bolt clamps) and shall have dimensions in inches not less than the following:

NPS	LENGTH	THICKNESS
1 through 3-1/2	12	0.048
4	12	0.060
5 & 6	18	0.060

8 through 14	24	0.075
16 through 24	24	0.105

3. Pipes 8 inches and larger shall have wood inserts.
4. Insert materials shall be at least as long as the protective shield.
   Provide manufacturer-recommended saddles, inserts, and/or shields where cellular foam insulation is used. The removal of sections of cellular foam insulation for the purpose of pipe support is not acceptable.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls and floors.

B. Flash drains in floors with topping over finished area with lead, inches clear on sides with minimum 36 x 36 inch sheet size. Fasten to drain clamp device.

C. Seal floor, shower, mop sink, etc. drains watertight to adjacent materials.

D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe and duct sleeves are not required for penetrations through non-rated concealed partitions.

B. Wall sleeves shall not be used to support pipes or ducts.

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Size so as to allow for continuous insulation wrapping through sleeve.

E. Sleeves through floors shall extend a minimum 2” above the finish floor level. Sleeves through walls should be flush with wall surface.

F. Where piping or ductwork penetrate non-rated ceilings or walls, close off space between pipe or duct and adjacent work with urethane rod stock and caulk air tight.

G. Seal pipe and duct penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.
3. Where ductwork is not located in a rated shaft and it penetrates a single non-rated floor, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.
4. Where ductwork is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound. Install fire damper in duct at each floor level. Ductwork containing fume exhaust air shall not be provided with fire dampers.

H. Where piping or ductwork penetrate rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.

I. Provide on ductwork close fitting metal collar or escutcheon covers on the side of penetration that are exposed to view.

J. Install chrome plated steel escutcheons on piping at finished surfaces.

K. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

L. All ductwork through exterior walls to be installed with flashing and counter flashing.

3.8 HANGER SCHEDULES

A. Reference International Plumbing Code and International Mechanical Code where applicable.

END OF SECTION 23 05 29

SECTION 23 05 30 – HVAC FIRESTOPPING

1. GENERAL

1.1 SUMMARY

A. Through Penetration Firestop Systems for protection of penetrations through following fire resistance rated assemblies, including both blank openings and openings containing penetrating items:

1. Floor assemblies.
2. Roof assemblies.
3. Wall and partition assemblies.
4. Fire-rated smoke barrier assemblies.
5. Construction enclosing compartmentalized areas.
6. Existing, fire and smoke-rated assemblies.

B. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.2 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire-rated wall and horizontal assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For penetration firestopping sealants and sealant primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For penetration firestopping sealants and sealant primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

a. Provide Engineering Judgment or Equivalent Fire Resistance Rated Assembly (EFRRA) for submittal derived from similar UL system designs or other tests approved by local authorities having jurisdiction, prior to installation.
b. Engineering judgment drawings must follow requirements set forth by International Firestop Council.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Provide firestop systems in compliance with following requirements:

1. Obtain firestop system for each type of penetration and construction condition from a single firestop systems manufacturer.
2. Firestop products and systems shall bear classification marking of qualified testing and inspection agency.
3. Firestopping tests, performed by qualified, testing and inspection agency.

a. UL or other agency, performing testing and follow-up inspection services for firestop systems, acceptable to local authorities having jurisdiction.

B. Installer Qualifications:

1. Certified, licensed or approved by firestopping manufacturer, trained to install firestop products per specified requirements.
2. Licensed by State or local authority, where applicable.
3. Shown to have successfully completed not less than five (5) comparable scale projects.

C. Fire Test Requirements:

1. Underwriters Laboratories, Inc. (UL):

a. UL 263, Fire Tests of Building Construction and Materials
b. UL 723, Surface Burning Characteristics of Building Materials
c. UL 1479, Fire Tests of Through Penetration Firestops
d. UL 2079, Tests for Fire Resistance of Building Joint Systems

2. ASTM International (ASTM):

a. ASTM E84 Surface Burning Characteristics of Building Materials
b. ASTM E119 Fire Tests of Building Construction and Materials
c. ASTM E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750F
d. ASTM E814 Fire Tests of Through Penetration Fire Stops
e. ASTM E1399 Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
f. ASTM E1966 Test Method for Fire Resistive Joint Systems
g. ASTM E2174 Standard Practice for On-site Inspection of Installed Fire Stops
h. ASTM E2307 Standard Test Method for Determining the Fire Endurance of Perimeter Fire Barrier Systems Using the Intermediate-Scale, Multi Story Test Apparatus (ISMA)
i. ASTM E2393 Standard Practice for On-site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers

D. References:

1. Building Code as locally adopted and amended.
2. Underwriters Laboratories (UL) Fire Resistance Directory:

    a. Through Penetration Firestop Systems (XHEZ).
    b. Joint Systems (XHBN).
    c. Fill, Void or Cavity Materials (XHHW).
    d. Firestop Devices (XHJI).
    e. Forming Materials (XHKU).
    f. Wall Opening Protective Materials (CLIV).

3. National Fire Protection Association (NFPA):

    a. NFPA 70: National Electrical Code
    b. NFPA 101: Life Safety Code
    c. NFPA 22: Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls
    d. NFPA 251: Fire Tests of Building Construction and Materials

4. Firestop Contractors International Association (FCIA):

    a. MOP – FCIA Firestop Manual of Practice

5. International Firestop Council, latest edition (IFC):

    a. Ref. 1 Recommended IFC Guidelines for Evaluating Firestop Engineering Judgments
    b. Ref. 2 Inspectors Field Pocket Guide

E. Identification Labels for Firestop Assemblies:

1. Follow guidelines set in Chapter 7 of International Building Code.

F. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
    b. Classification markings on penetration firestopping correspond to designations listed by the following:

        1) UL in its "Fire Resistance Directory."

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

C. Install products within the time period of the manufacturer's warranty. Note that some products have short warranty periods after purchase.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

1.8 WARRANTY

A. Manufacturer Warranty:

1. Provide written warranty to Owner, guaranteeing performance of installed firestop material as designed and tested, for sustainable lifetime of structure; defect in material shall be replaced at no cost to Owner.

B. Installer Warranty:

1. Provide written warranty to Owner guaranteeing quality of installation and meeting requirements of manufacturers written instructions and tested system, for a minimum of five (5) years. Deficiencies found in installed firestop shall be repaired or replaced at no cost to Owner.

2. PRODUCTS

2.1 MANUFACTURERS

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

1. Hilti, Inc.
2. 3M Fire Protection Products.
3. Or equivalent manufacturers of UL listed systems, listed in UL Building Materials Directory.

B. All firestopping for Div. 21, 22, and 23 shall be provided by a single manufacturer.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls, and fire partitions. See code plan drawing for locations.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies. See code plan for locations.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. Smoke barriers include smoke-barrier walls and smoke-barrier floors. See code plan drawing for locations.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
3. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

H. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

I. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-wool-fiber or rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 PENETRATION SEALING

SECTION 23 05 30 – HVAC FIRESTOPPING

A. Provide penetration sealing that is produced and installed to resist spread of smoke and air according to requirements indicated. Penetration sealing systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Smoke Partitions: Provide penetration sealing meeting requirements of IBC, Chapter 7.

1. Smoke partitions include smoke-partition walls. See code plan drawing for locations.
2. Material/system shall be approved to limit the free passage of smoke at 400° F.

C. Penetrations in Non-Rated Walls Serving Pressurized Spaces: Provide penetration sealing of all openings.

1. See drawings for locations of wall serving pressurized areas.

D. Penetrations in Sound-Rated Walls: Provide penetration sealing of all openings.

1. See drawings and specifications for locations of sound-rated walls.
2. Material/system shall have the same overall STC rating as the wall assembly.

E. Penetrations in Floors: Provide penetration sealing meeting requirements of IBC, Chapter 7.

1. Material/system shall be approved to limit the free passage of flame and products of combustion.

F. Exposed Penetration Sealing: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

G. VOC Content: Penetration sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

H. Low-Emitting Materials: Penetration sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

I. Accessories: Provide components for each penetration sealing system that are needed to install fill materials and to maintain performance required. Use only those components specified by penetration sealing manufacturer and approved by qualified testing and inspecting agency for sealing indicated.

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-wool-fiber or rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.

5. Steel sleeves.

2.4 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.5 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

3. EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping and/or sealing to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping and/or sealing.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping and/or sealing. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping and/or sealing from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's and/or sealant’s seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping and/or sealing to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings and/or performance indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping or sealant.

C. Install fill materials for firestopping and/or sealing by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

D. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings.

1. Provide products appropriately tested for the thickness and type of insulation utilized.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections of firestopping.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping and/or sealant manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping and/or sealing is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and/or sealant and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE

A. General:

1. Schedules below identify requirements for acceptable through penetration firestop systems based on barrier type, fire-resistive rating, and penetrant type. Each system must comply with building code and fire code as locally adopted and amended.
2. Requirements for single-membrane penetrations and through penetration firestops are identical. Unless otherwise noted, penetrants which pass through a single membrane, shall be treated the same as if it passed through the entire fire-resistive assembly.
3. Select each firestop system based on actual field conditions, including penetration type, shape, size, quantities and physical position within opening.

    a. If the actual conditions do not match a manufacturer’s standard firestopping condition, provide an Engineering Judgment or Equivalent Fire Resistance Rated Assembly (EFRRA) for submittal derived from similar UL system designs or other tests approved by local authorities having jurisdiction, prior to installation.

4. Refer to plans for indication of the required ratings of wall, floor, and roof assemblies.
5. Indicated ratings are minimum and may be exceeded.

B. Firestop Assemblies at Fire-Rated Walls:

a. The minimum Fire (F) Rating for Firestop assemblies in walls shall equal that of the wall, but not less than 1-HR.
b. The minimum Temperature (T) Rating of Firestop assemblies in walls may equal zero.
c. Smoke Barrier: In addition to (F) Rating, (L) Rating of maximum 5 CFM per SF.
d. Non-rated walls and Smoke-Partitions with no fire-resistive requirement: Assembly with (L) rating.

C. Firestop Assemblies at Fire-Rated Floors and Roofs:

a. Minimum Fire (F) and Temperature (T) Ratings of Firestop assemblies used in floors or roof shall equal hourly rating of floor or roof being penetrated, but not less than 1-HR.

1) Exception 1: The T-rating may equal zero when portion of penetration, above or below floor, is contained within a wall.
2) Exception 2: Firestops are not required for floor penetrations within a 2-hour rated shaft enclosure.

D. Voids in Wall with No Penetrations:

1. Fill with approved through penetration firestopping system.
2. Contractor's option: Patch void in wall with like construction.

E. Penetrating Ducts with Dampers:

1. Utilize only firestop materials which are included in damper's classification.
2. Do not install firestop systems that hamper performance of fire dampers.

F. Cable Trays and Similar Devices:

1. Provide re-enterable products specifically designed for removal and re-installation at openings within walls and floors designed to accommodate voice, data and video cabling.
2. Where cable trays are used:

a. Utilize re-enterable products (e.g. removable intumescent pillows) specifically designed for retrofit.

3. Where cable trays are not used:

a. Utilize fire-rated cable pathway devices.
b. Where not practical, re-enterable products designed for retrofit may be used.

G. Panels, Devices, Medical Gas Outlets, Valve Boxes, and Other Items Recessed into Face of Rated Walls:

1. Where devices are placed on opposite sides of wall, and are less than 24 IN apart measured horizontally, install intumescent pads over back of devices in approved manner or maintain continuity of rated barrier within wall cavity surrounding recessed item.

3.8 PENETRATION SEALING SCHEDULE

A. General:

1. Schedules below identify requirements for acceptable penetration sealing systems based on assembly type and penetrant type. Each system must comply with building code and fire code as locally adopted and amended.
2. Requirements for single-membrane penetrations and penetration sealants are identical. Unless otherwise noted, penetrants which pass through a single membrane, shall be treated the same as if it passed through the entire assembly.
3. Select each sealing system based on actual field conditions, including penetration type, shape, size, quantities and physical position within opening.

B. Sealing Assemblies at Walls:

1. Smoke-Partitions with no fire-resistive requirement: Assembly with (L) rating of maximum 5 CFM per SF.
2. Walls Separating Pressurized Areas: Non-hardening silicone sealant throughout all openings.
3. Sound-Rated Walls: Fiberglass insulation stuffed in all openings and sealed on both sides with non-hardening silicone sealant.

C. Sealing Assemblies at Floors and Roofs:

1. Walls Separating Pressurized Areas: Non-hardening silicone sealant throughout all openings.
2. Sound-Rated Walls: Fiberglass insulation stuffed in all openings and sealed on both sides with non-hardening silicone sealant.

D. Voids in Wall with No Penetrations:

1. Fill with approved through penetration firestopping system.
2. Contractor's option: Patch void in wall with like construction.

E. Penetrating Ducts with Dampers:

1. Utilize only firestop materials which are included in damper's classification.
2. Do not install firestop systems that hamper performance of fire dampers.

F. Cable Trays and similar devices:

1. Provide re-enterable products specifically designed for removal and re-installation at openings within walls and floors designed to accommodate voice, data and video cabling.
2. Where cable trays are used:

    a. Utilize re-enterable products (e.g. removable intumescent pillows) specifically designed for retrofit.

3. Where cable trays are not used:

    a. Utilize fire-rated cable pathway devices.
    b. Where not practical, re-enterable products designed for retrofit may be used.

G. Panels, devices, medical gas outlets, valve boxes, and other items recessed in to face of rated walls:

1. Where devices are placed on opposite sides of wall, and are less than 24 IN apart measured horizontally, install intumescent pads over back of devices in approved manner or maintain continuity of rated barrier within wall cavity surrounding recessed item.

SECTION 23 05 30 – HVAC FIRESTOPPING

END OF SECTION 23 05 30

SECTION 23 05 48 – HVAC VIBRATION CONTROLS

1. GENERAL

1.1 Coordinate requirements of this specification with all other specifications and trades. Requirements of this specification take precedence over other specification sections. For example, the requirements of this section with regard to pipe supports in mechanical rooms take precedence above the requirements of Section 23 05 29.

1.2 This specification pertains to the furnishing and installation of vibration isolation devices for rotating or reciprocating mechanical equipment and piping and conduit systems attached thereto, and electrical transformers and attached switchgear and conduit systems.

1.3 This work shall include all material and labor required for installation of the resilient mounting and suspension systems, adjusting each mounting system, and measurement of isolator system performance when so requested by the Architect. Specific mounting arrangements for each item of mechanical and electrical equipment shall be as described herein and as indicated by schedules and details on the drawings.

1.4 All vibration isolation equipment except for resilient pipe connectors, including steel framing and reinforcing for concrete inertia bases and including steel rail bases, shall be furnished by Mason Industries or Kinetics Noise Control. A single manufacturer for all vibration isolation equipment in Sections 22 05 48, 23 05 48, and 26 05 48 will be required except as specifically approved in writing by the Architect or by his specific approval of shop drawings or as specified herein. For resilient pipe connectors refer to provisions of this specification that follow.

1.5 SECTION INCLUDES

A. Vibration isolation systems.

1.6 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Delivery, storage and handling

1.7 ADDITIONAL REQUIREMENTS

A. The Contractor and the vibration isolation manufacturer or his regularly designated and factory authorized representative shall perform the following tasks in addition to the supply and installation of isolation equipment:

1. Obtain from the Architect the approved manufacturer's name, model number, and other necessary identifying data for each item of mechanical and electrical equipment to be resiliently mounted. Coordinate all resilient mounting systems with the exact equipment to be furnished in regard to physical size, isolator locations, weight, rotating speed, etc. Direct contact and cooperation between the vibration isolation device fabricator and the equipment manufacturer will be required.
2. Obtain all necessary data in regard to piping systems which are to be resiliency supported so that proper isolators can be selected. Select piping system isolators for proper coordination with the physical arrangement of pipe lines and with the physical characteristics of the building.
3. Submit shop drawings as required by other portions of this specification. These drawings shall include specification information as follows:

a. Manufacturer's model number for each isolator, the machine or pipeline to which it is to be applied, and the number of isolators to be furnished for each machine or pipeline.
b. For steel spring mounts or hangers - Free height, deflected height, solid height, isolator loading, and diameter of spring coil.
c. For elastomer or glass fiber isolators - Free height, deflected height, and isolator loading.
d. Dimensional and weight data for concrete inertia bases, steel and rail bases, and details of isolator attachment.

4. Provide on-the-job supervision as required during installation of resiliently mounted equipment and piping to assure that all vibration isolators are installed in strict accordance with normally accepted practices for critical environments.
5. Replace at no extra cost to the Owner any isolators which do not produce the required deflection, are improperly loaded above or below their correct operating height, or which in any way do not produce the required isolation.
6. Cooperate with all other Contractors engaged in this project so that the installation of vibration isolation devices will proceed in a manner that is in the best interests of the Owner.
7. Notify the Architect of any project conditions which affect vibration isolation system installation or performance and which are found to be different from conditions indicated by the drawings or described by the specifications. Should vibration isolation system installation proceed without such notifications any remedial work required to achieve proper isolator performance shall be accomplished by the Contractor at no additional cost to the Owner.
8. Be alert for possible "short-circuiting" of vibration isolation systems by piping supports, electrical connections, temperature control connections, drain lines, building construction, etc., and notify the involved contractor as to these problems or potential problems. Where such situations cannot be easily resolved, notify the Architect so that preventive or remedial action can take place on a timely basis. Any remedial measures required shall be undertaken by the contractor responsible at no additional cost to the Owner.
9. This specification does not include provisions for seismic restraints that might be required by isolations systems due to the geographic location of the project, building codes, or other considerations.

2. PRODUCTS

2.1 VIBRATION ISOLATION SYSTEMS:

1. General:

a. The vibration isolation systems described herein and identified by type letter designations shall be applied to specific classifications of mechanical and electrical equipment as indicated by Section C of this document.
b. The minimum static deflection of the isolators for each classification of mechanical or electrical equipment shall be as indicated by Section C of this document or as otherwise indicated herein.

2. Type A Isolation:

a. The equipment shall be rigidly mounted on a large reinforced concrete inertia base which has length and width dimensions approximately 20% greater than the supported equipment. The inertia base and equipment shall be supported by steel spring vibration isolators. Brackets for the spring isolators shall be located off the sides of the inertia base or integral with the perimeter of the inertia base with the tops of the springs near the vertical center of gravity of the equipment and inertia block; or if the center of gravity is higher than the top of the inertia base, the tops of the springs shall be at the top of the inertia base. The spring isolators shall rest on curbs or pedestals if necessary. There shall be a 2 inch minimum space between the bottom of the inertia

base and the top of the housekeeping pad or floor slab when a housekeeping pad is not indicated to be employed.

b. Concrete inertia bases shall be formed by a welded steel channel frame which incorporates prelocated equipment anchor bolts, and reinforcing bars in each direction welded in place. Concrete shall be standard 150-160 lb/cu.ft. structural concrete. The base thickness shall be determined by the weight requirements but it shall be a minimum of 8% of the longest span between isolators or 6 inches, whichever is greater. For centrifugal and axial fans and centrifugal pumps the inertia base shall have a minimum weight equal to that of the isolated equipment. For reciprocating equipment the inertia base shall have a minimum weight equal to twice the weight of the equipment.

c. Springs shall be of the free standing unhoused type. Horizontal spring stiffness shall not be less than 0.8 of vertical stiffness. Springs shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each spring shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than 1/2 of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure. At least two layers of ribbed waffle pattern neoprene pads or equivalent glass fiber pads shall be installed under the base plate of each spring isolator. Springs shall have leveling bolts and proper means for bolting to the machines. To prevent corrosion, springs for outdoor installation shall be galvanized or otherwise coated as approved by the Architect.

3. Type B Isolation:

a. The equipment shall be rigidly mounted on wide flange or channel structural steel members which shall run perpendicular to any support channels or similar members which are an integral portion of the equipment, or which shall be fabricated to form a complete frame for machine mounting. Height saving spring mounting brackets shall be welded to the ends of the structural steel saddle members or to the sides of structural steel frames to attach free standing steel spring isolators. Unless otherwise approved, the depth of the structural steel saddle members or the perimeter members of mounting frames shall be at least one-tenth of the longest frame dimension.

b. Steel spring isolators shall be as specified for Type A isolation.

c. Minimum clearance between the steel base and the housekeeping pad or floor shall be 2 inches.

4. Type C Isolation:

a. The equipment shall be rigidly mounted in a steel frame which is sufficiently stiff so that it may be supported on resilient isolators without distortion of the frame or misalignment of the equipment. If the equipment has an integral frame which is suitably rigid, the resilient isolators may be secured directly to the integral equipment frame or base.

b. Isolators shall be selected on the basis of the required static deflection as scheduled or otherwise indicated, and as follows:

1) Required deflection 0.25 to 0.4 inches - double deflection neoprene-in-shear isolators.

2) Required deflection 0.5 inches and greater - steel spring isolators as specified for the Type A mounting.

c. Isolators shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection shall not be less than that specified for each classification of equipment.
d. Minimum clearance between the equipment base and the house keeping pad or floor shall be 2 inches.

5. Type D Isolation:

a. The equipment shall be mounted on resilient "pads". These pads shall be multiple layers of waffle or ribbed neoprene, neoprene and cork sandwich, or precompressed glass fiber with height and stiffness as required to provide the static deflection as scheduled or specified and as required to properly support the load.
b. Pads shall be loaded in accordance with the manufacturer's recommendations and sized to achieve this recommended loading. The equipment weight at each sup porting point shall be considered in selecting pad dimensions along with the recommended loading.

6. Type E Isolation:

a. The equipment shall be suspended with steel spring vibration isolators which are complete with neoprene-in-shear isolators for high frequency noise control. The neoprene-in-shear isolators shall provide static deflection of 0.20 inches minimum. In addition, elastomer washers shall be furnished as necessary to prevent metal-to-metal contact.
b. Hanger rod misalignment of up to 15 degrees relative to vertical shall not cause "short-circuiting" of the isolation components due to metal-to-metal contact.
c. Spring hangers shall utilize free standing springs which are unhoused except for the required partial and open housing assembly. Spring hangers shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each hanger shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than one-half of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure.
d. Resilient hangers shall be installed as near as possible to the supporting overhead structure. The machine suspension points shall be in a rigid and heavy portion of the building structure. Suspension of machines from lightweight floor slabs shall be avoided, particularly at the center of structural spans.
e. Suspension rods shall be attached to rigid members of the machine structure. When such attachment points do not exist, a heavy steel framework shall be furnished to support the machine with suspension rods attached to this framework.

7. Type F Isolation:

a. The equipment shall be suspended with double deflection neoprene-in-shear hangers which are complete with elastomer washers as required to prevent metal-to-metal contact.
b. Hangers shall be installed as near as possible to the supporting overhead structure. Suspension points shall be on a rigid portion of both the overhead structure and equipment framework.

8. Type G Isolation:

a. This mounting shall be the same as the Type E mounting except that the suspended machine shall be supported by a concrete inertia base. Suspension rods shall be attached to the concrete base.

9. Type K Isolation (Curb Mounted Roof-top Air Conditioning Machines):

a. The roof-top air conditioning machine shall be mounted on a free standing steel spring isolated rectangular rail (curb) system. The isolation system shall be suitable for outdoor unprotected locations and it shall include a soft and flexible elastomer air and water seal which shall not short circuit the spring isolators. The isolation system shall not allow lateral movement greater than 5/8 inch for wind loads up to 100 miles per hour. Suitable systems of this type are Kinetics Noise Control Type ESR and Mason Industries Type RSC.

10. Type L Isolation (Water Chillers and Similar Equipment):

a. Same as Type C except that steel spring isolators shall employ vertical limit stops with provisions to prevent short circuiting of the limit stops when the springs are loaded normally.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 RESILIENT MOUNTINGS FOR SPECIFIC CLASSIFICATIONS OF MECHANICAL EQUIPMENT:

EQUIPMENT	LOCATION	ESTIMATED MINIMUM ROTATING SPEED (RPM)	ISOLATION TYPE	MINIMUM ACTUAL STATIC DEFLECTION (INCHES)

3.6 ISOLATION OF PIPING SYSTEMS:

A. All piping and rigidly connected devices such as pressure reducing valves which connects to resiliently mounted equipment shall be suspended with resilient hangers or supported by floor mounted isolators for a distance of 100 pipe diameters from the connected machine or within the mechanical equipment room, whichever is the greater distance. The first three supports from the connected machine shall have the same static deflection as indicated for the machine; the next two supports shall have static deflection at least equal to one-half of the static deflection indicated for the machine mounting, and remaining pipe supports shall provide static deflection of 0.35 inches minimum. These remaining isolators may be elastomer.

B. Steel spring hangers shall be as specified for Type E isolation except that a scale shall be attached to the hanger housing to indicate deflection. Elastomer hangers shall be as specified for Type F isolation. Floor mounts shall be free standing steel spring isolators as specified for Type A isolation where static deflection in excess of 0.35 inches is required. Floor mounts, where static deflection of 0.35 inches or less is required, shall be double deflection neoprene-in-shear as specified for Type C isolation.

C. Vertical pipe risers shall be resiliently mounted, preferably with each riser anchored near the center of the run. The risers shall be supported at the anchor points with steel spring or double deflection neoprene-in-shear isolators which provide static deflection of at least 0.35 inches. Isolators for the remainder of each run shall be steel spring type specifically designed to control load shifting due to pipe expansion and contraction. At least 0.35 inches deflection shall be maintained under all conditions.

D. Flexible synthetic rubber connectors shall be used to connect all piping to all isolated equipment. Flexible synthetic rubber connectors shall be fabricated using peroxide cured EPDM synthetic rubber and Kelvar tire cord reinforcement and shall be Mason Industries Safeflex of the most current design. Resilient connectors shall be selected for the pressure rating and temperature rating appropriate for the particular piping and pipe contents. Where synthetic EPDM flexible connectors are not permitted by code due to pipe contents and/or pressures provide swing pipe connectors changing direction a minimum of 3 times before joining isolated equipment. Swing connections should be made within approximately 6 feet of the isolated equipment.

E. Drain connections from isolated equipment to floor drains shall be at least 1" free from drain or use rubber hose.

3.7 ISOLATION OF AIR SUPPLY AND RETURN DUCTS

A. Sheet metal air handling ducts shall be connected to air handlers with resilient connectors and such ducts shall be suspended with resilient hangers or supported by floor mounted isolators for a distance of 30 feet from the connected machine or within the mechanical equipment room whichever is the greater distance. The first three supports from the connected machine shall have the same static deflection as indicated for the machine; the next two supports shall have static deflection at least equal to one-half of the static deflection indicated for the machine mounting, and remaining pipe supports shall provide static deflection of 0.35 inches minimum. These remaining isolators may be elastomer.

B. Steel spring hangers shall be as specified for Type E isolation. Elastomer hangers shall be as specified for Type F isolation. Floor mounts shall be free standing steel spring isolators as specified for Type A isolation where static deflection in excess of 0.35 inches is required. Floor mounts, where static deflection of 0.35 inches or less is required, shall be double deflection neoprene-in-shear as specified for Type C isolation.

3.8 ISOLATION OF FRACTIONAL HORSEPOWER EQUIPMENT:

A. All fractional horsepower fans, pumps, etc., which are mounted on or suspended from floors that are not on-grade shall be isolated with neoprene-in-shear isolators furnished by the vibration isolation supplier except where such isolators are furnished as an integral part of the machine.

END OF SECTION 23 05 48

SECTION 23 05 53 - HVAC IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe Markers.

D. Ceiling Tacks/Stickers.

E. Duct Markers.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents

1. Record actual locations of tagged valves.

F. Delivery, storage, and handling.

2. PRODUCTS

2.1 NAMEPLATES

A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.

B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.

B. Chart: Provide valve list in electronic spreadsheet format. Valve list to be submitted with O&M materials. Valve list shall correspond to any mechanical piping schematics on plans.

C. Pipe Schematics: Valve numbers are to be labeled on electronic copies of Engineer's schematic drawings. Final schematic to be submitted with O&M materials.

2.3 PIPE MARKERS

A. Color: Conform to ASME A13.1, latest revision

B. Plastic Tape Pipe Markers: Minimum 1-1/2" letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4-mil thick, manufactured for direct burial service. Provide tape with printing which most accurately indicates the type of service of buried pipe.

2.4 CEILING TACKS/STICKERS

A. Description: ½" self adhesive color coded stickers.

B. Color code as follows:

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers, sprinkler/standpipe system valves
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

2.5 DUCT MARKERS

A. Plastic Tape Duct Markers: Minimum 1-1/2" letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed marking; minimum information indicating flow direction arrow and identification of air system being conveyed.

3. EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe and duct markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.

D. Identify air handling units, exhaust fans, chillers, pumps, heat generating, heat rejecting, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

E. Identify pressure reducing valves, backflow preventers, valves, and meters with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments, and relays. Key to control schematic.

I. Identify piping, concealed or exposed, with plastic tape pipe markers. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locations of identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

J. Provide ceiling stickers or machine generated labels to locate valves, dampers, or HVAC equipment above T-bar type panel ceilings. Locate ceiling sticker on the ceiling grid closest to equipment. Label each sticker with the device located above the ceiling, i.e. VBR-33.

K. Identify ductwork with plastic tape duct markers. Identify service, flow direction and pressure when applicable, i.e. low pressure supply air, high pressure supply air. Install in clear view from floor and align with centerline of duct. Locations of identification not to exceed 15 feet from straight runs including risers and drops, more often in congested areas, at each side of penetration of structure or wall, and at each obstruction. When several ducts from different units are located in concealed congested areas, locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Testing, adjustment, and balancing (TAB) of air, hydronic and plumbing systems.

1.3 SUMMARY:

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

a. Balancing airflow and water flow within distributions systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
b. Adjusting total HVAC systems to provide indicated quantities.
c. Measuring electrical performance of HVAC equipment.
d. Setting quantitative performance of HVAC equipment.
e. Verifying that automatic control devices are functioning properly.
f. Measuring sound and vibration.
g. Measuring and testing smoke management systems.
h. Reporting results of the activities and procedures specified in this Section.

B. Testing, Adjusting and Balancing shall be by UNL BSM and is not part of the Contractor's scope of work.

1. Contractor is responsible for coordinating all activity with UNL BSM for equipment / device accessibility inspections at intervals not less than monthly and more frequently during periods of high activity to assure installation of piping, ductwork, and pipe/duct accessories including those items furnished by UNL BSM are accessible. Contractor shall submit monthly report signed by UNL BSM as testament to this inspection service.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCTWORK INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Ductwork insulation.

B. Duct liner.

C. Insulation jackets.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Delivery, Storage, and Handling.

D. Quality assurance.

1. Materials: ASTM E84 Flame spread/smoke developed rating of 25/50 or less.

E. Qualifications.

1. Applicator: Company specializing in performing the work of this section with minimum three years' experience.

F. Environmental requirements.

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation as recommended by the manufacturer.

2. PRODUCTS

2.1 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.

1. 'K' value: ASTM C518, 0.30 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Maximum moisture absorption: less than 3 percent by volume.
4. Density: 1.5 lb/cu ft.

B. Vapor Barrier Jacket

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm maximum.
3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

D. Tie Wire: Annealed steel, 16 gage (1.5 mm).

2.2 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible blanket.

1. 'K' value: ASTM C518, 0.23 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Maximum moisture absorption: less than 3 percent by volume.
4. Density (concealed locations): 3.0 lb/cu ft.
5. Density (exposed locations): 6.0 lb/cu ft.

B. Vapor Barrier Jacket

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.3 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, sheet.

1. 'K' ('ksi') Value: ASTM C177 or C518; 0.27 at 75 degrees F.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM D209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.08 perm-inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 DUCT LINER

A. Flexible Polyimide Foam Duct Liner: Preformed, polyimide foam coated with acrylic polymer, sheet materials complying with NFPA 90A or NFPA 90B. Evonik Industries model Solcoustic or equivalent.

1. Indoor Air Quality Characteristics: Fiber-free and formaldehyde-free.
2. Odor Characteristics: No objectionable odors when tested using ASTM C1304
3. Mold Growth Characteristics: Meets requirements of UL181
4. Fungi Resistance Characteristics: Meets requirements of ASTM G21
5. Bacterial Resistance Characteristics: Meets requirements of ASTM G22
6. Antibacterial Coating: EPA-registered for use in air duct insulation
7. Erosion Resistance Characteristics: Does not break away, flake off, or show evidence of delamination at velocities of 5,000 ft/min, tested at ASTM C1071
8. 'K' value: ASTM C518, 0.30 at 75 degrees F.
9. Maximum service temperature: 250 degrees F.
10. Maximum moisture absorption: less than 2.0 percent by volume.
11. Maximum Flame Spread: ASTM E84; 25.

12. Maximum Smoke Developed: ASTM E84; 50.
13. Density: 0.8 lb/cu ft.
14. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

15. Sound Absorption at 1" thickness: ASTM C423 and ASTM E795

    a. 125 Hz: 0.11
    b. 250 Hz: 0.30
    c. 500 Hz: 0.73
    d. 1 kHz: 1.02
    e. 2 kHz: 0.73
    f. 4 kHz: 0.66
    g. NRC: 0.70

B. Cellular Foam Duct Liner: ASTM C534; flexible, cellular elastomeric, sheet.

1. 'K' ('ksi') Value: ASTM C177 or C518; 0.28 at 75 degrees F.
2. Minimum Service Temperature: -297 degrees F.
3. Maximum Service Temperature: 180 degrees F.
4. Maximum Moisture Absorption: ASTM D209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.08 perm-inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.
9. AP Armaflex FS Self-Adhering Sheet Insulation or equivalent.

2.5 EXTERIOR DUCT INSULATION

A. Laminated Cellular Foam; closed cell foam insulation with metal covering.

1. 'K' ('ksi') Value: ASTM C177 or C518; 0.25 at 75 degrees F.
2. Minimum Service Temperature: -297 degrees F.
3. Maximum Service Temperature: 180 degrees F.
4. Maximum Moisture Absorption: ASTM D209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.05 perm-inches.
6. Connection: Waterproof vapor barrier adhesive.
7. Armaflex Armatuff Sheet Insulation or equivalent.

B. Polyisocyanurate Foam Sheathing: ASTM C1289; Foil-faced uniform closed-cell board. Johns Manville AP Foil-Faced or equivalent.

1. 'R' Value: 9.0 at 1-1/2" board thickness.
2. Minimum Service Temperature: -100 degrees F.
3. Maximum Service Temperature: 250 degrees F.
4. Moisture Vapor Transmission: ASTM E96; 0.03 perm-inches.
5. Connection: Waterproof vapor barrier adhesive.
6. Field applied jacketing: MFM FlexClad 400 or equivalent; 40 mil thickness.

    a. Aluminum jacket with high-density cross-linked polymer film.
    b. Aggressive Asphalt adhesive.

3. EXECUTION

3.1 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

C. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

D. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

E. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

F. Secure insulation without vapor barrier with staples, tape, or wires.

G. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.

H. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

I. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

J. Do not overtighten and/or compress flexible glass fiber duct insulation.

K. At duct access doors or other openings, insulation shall be properly framed and finished.

L. Duct Liner Application:

1. Install in accordance with SMACNA HVAC Duct Construction Standard and all manufacturer recommendations.
2. Adhere insulation with adhesive for 100 percent coverage.
3. Secure insulation with mechanical liner fasteners if recommended by manufacturer. Refer to SMACNA Standards for spacing.
4. Seal and smooth joints.
5. Seal liner surface penetrations with adhesive.
6. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

M. Exterior Insulation Application:

1. Laminated closed cell foam:

    a. Install in accordance with manufacturer's recommendation.
    b. Utilize product compliant adhesives or pre-applied pressure sensitive adhesives.
    c. Cover seams with product compliant seal tape.

2. Polyisocyanurate:

    a. Install in accordance with manufacturer's recommendation.
    b. Use product compliant adhesive for board installation
    c. Taper insulation on top of ductwork to allow positive drainage.
    d. Field-apply jacketing using pressure-sensitive adhesive and hand roller.
    e. Install jacketing continuous across bottom of ductwork extending minimum 6" up each side of duct. Pin duct bottoms over 36" in width.

3.3 GLASS FIBER DUCTWORK INSULATION SCHEDULE

Ductwork Application:	**Type:**	**Thickness:**	**Vapor Barrier Required (Y/N):**
Exposed rectangular outside air duct in mechanical rooms and chases	Rigid	2"	Y
Exposed rectangular supply air duct in mechanical rooms and chases	Rigid	2"	Y
Exposed round supply air duct in mechanical rooms	Flexible	2"	Y
Exposed rectangular and round return air duct in mechanical rooms	None required unless shown on plans		
Exposed rectangular and round exhaust air duct upstream of heat recovery system in mechanical rooms	None required unless shown on plans		
Exposed rectangular and round exhaust/relief air duct downstream of heat recovery system in mechanical rooms	Rigid	2"	Y
Exposed rectangular and round return air duct or exhaust air duct in other areas	None required unless shown on plans		
Exposed rectangular and round supply air duct upstream of terminal units	Flexible	2"	Y
Exposed rectangular supply air duct downstream of terminal units	Liner	1-1/2"	Y
Exposed round supply air duct downstream of terminal units	Flexible	2"	Y
Concealed rectangular and round supply air duct upstream of terminal units	Flexible	2"	Y
Concealed rectangular supply air duct downstream of terminal units	Liner	1-1/2"	Y
Concealed round supply air duct downstream of terminal units	Flexible	2"	Y
Concealed return air duct upstream of terminal units	Liner	1"	Y
Concealed exhaust air duct	None required unless shown on plans		
Return air grille boots/transfer ducts (where indicated on drawings)	Liner	1"	N
Exterior Ductwork	Exterior	2"	Y

SECTION 23 07 13 - DUCTWORK INSULATION

Schedule Notes:

A. All ductwork in mechanical rooms shall be insulated as though it were “Exposed”.

B. Any exterior ductwork requiring insulation from the categories above shall be insulated as “Exterior.”

END OF SECTION 23 07 13

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

C. Breeching insulation

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References

B. Submittals

C. Quality Assurance

1. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723.

D. Delivery, Storage and Handling

E. Environmental Requirements

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible.

1. 'K' ('ksi') value: ASTM C335, 0.24 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.
4. Density: 2.0 lb/cu ft.

B. Vapor Barrier Jacket

1. ASTM C921, kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.2 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible.

1. 'K' ('ksi') value: ASTM C335, 0.24 at 75 degrees F.
2. Maximum service temperature: 450 degrees F.
3. Maximum moisture absorption: 0.1 percent by volume.
4. Density: 3.0 lb/cu ft.

B. Vapor Barrier Jacket

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Vapor Barrier Lap Adhesive: Compatible with insulation.

D. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'K' ('ksi') value: ASTM C177 or C518; 0.27 at 75 degrees F.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature: 220 degrees F.
4. Maximum moisture absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
5. Moisture vapor transmission: ASTM E96; 0.20 perm inches.
6. Maximum flame spread: ASTM E84; 25.
7. Maximum smoke developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 CANVAS JACKET

A. Fabric: ASTM C921, 6 oz/sq yd, plain weave cotton treated with dilute fire retardant lagging adhesive.

B. Lagging Adhesive: Compatible with insulation.

3. EXECUTION

3.1 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Do not insulate factory insulated equipment.

C. On exposed equipment, locate insulation and cover seams in least visible locations.

D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Finish with glass cloth and vapor barrier adhesive.
3. Insulate entire system.

G. For insulated equipment containing fluids above ambient temperature:

H. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

1. Finish with glass cloth and adhesive.
2. For hot equipment containing fluids do not insulate flanges and unions, but bevel and seal ends of insulation.

I. Inserts and Shields:

1. Application: equipment 1-1/2 inches diameter or larger.
2. Shields: galvanized steel between hangers and inserts.
3. Insert location: between support shield and equipment and under the finish jacket.
4. Insert configuration: minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Finish insulation at supports, protrusions, and interruptions.

K. For equipment in mechanical equipment rooms or in finished spaces, finish with canvas jacket sized for finish covering.

L. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such labeling.

M. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

3.3 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 GLASS FIBER, RIGID INSULATION SCHEDULE

Equipment:	Thickness (inches):
Air handling units air handling unit section (if not factory insulated)	1-1/2"

3.5 CELLULAR FOAM INSULATION SCHEDULE

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION

Equipment:	Thickness (inches):
Cooling system air separators	1-1/2”
Cooling systems pump bodies	1-1/2"
Cooling systems flanged strainer bodies.	1-1/2"
Condensate drain pans	1-1/2”

END OF SECTION 23 07 16

SECTION 23 07 19 – HVAC PIPING INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, and UL 723.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Environmental requirements

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.

1. 'k' ((btu*in)/(hr*ft^2*deg F)) value : ASTM C335

Temperature (degrees F)	Maximum 'k' value (btu*in)/(hr*ft^2*deg F))
75	0.23
100	0.24
150	0.25
200	0.28
300	0.34
400	0.42
500	0.51

2. Minimum Service Temperature: 0 degrees F.
3. Maximum Service Temperature: 1000 degrees F.
4. Maximum Moisture Absorption: 0.2% by volume.

B. Vapor Barrier Jacket

1. ASTM C1136, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perms.
3. Secure with self-sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Vapor Barrier Lap Adhesive: MIL-A-3316C, Class 2, Grade A compliant. Compatible with insulation. VOC Limit 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Insulating Cement: ASTM C195; hydraulic setting on mineral wool. VOC Limit 70 g/L (multipurpose construction adhesive).

E. Fibrous Glass Fabric: Cloth, untreated; 9 oz/sq yd weight with 1.0 lb/cu ft density blanket.

F. Indoor Vapor Barrier Finish: Vinyl emulsion type acrylic, compatible with insulation, white color. VOC Limit 50 g/L.

2.2 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'k' ((btu*in)/(hr*ft^2*deg F)) value: ASTM C177 or C518; 0.22 to 0.28 at 60 degrees F.
2. Minimum Service Temperature: -20 degrees F.
3. Maximum Service Temperature: 180 degrees F.
4. Maximum Moisture Absorption: ASTM C209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.08 perm inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.
9. Provide documentation indicating that product contains no urea formaldehyde.
10. Fittings: Pre-fabricated closed cell fittings of like material and thickness as adjacent pipe insulation.
11. In all exposed finished areas without jacketing, provide white insulation, otherwise use black.

B. Elastomeric Foam Adhesive: MIL-A-24179A, Type II, Class I, compliant. Air dried, contact adhesive, compatible with insulation. VOC Limit: 50 g/L or less when calculated according to 40 CFR 59, Subpart D.

2.3 INSULATION BLANKETS FOR STEAM AND CONDENSATE FLANGED VALVES AND EXPANSION JOINTS

A. Insulation: Tight-fitting, reusable insulation blanket consisting of high-density insulation (fiberglass, mineral wool, ceramic fiber) covered on outside with coated glass fabric having heavy adjustable straps with buckles. Inside of blanket shall be covered with fabric suitable to specified temperature of stainless steel square mesh woven wire cloth. Insulation shall be a minimum of 1-1/2” thick and shall be suitable for temperatures up to 500 Deg. F.

2.4 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.

    a. Minimum Service Temperature: 0 degrees F.
    b. Maximum Service Temperature: 150 degrees F.
    c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
    d. Maximum Flame Spread: ASTM E84; 25.
    e. Maximum Smoke Developed: ASTM E84; 50.
    f. Thickness: 20 mil.
    g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

2. Covering Adhesive Mastic: Compatible with insulation and PVC jacket. VOC Limit 50 g/L according to 40 CFR 59, Subpart D (EPA Method 24).

B. Aluminum Jacket: ASTM B209.

1. Thickness: 0.040 inch.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: PVC pre molded fittings.
5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

3. EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Painting of cellular foam insulation is not allowed.

C. On exposed piping, locate insulation and cover seams in least visible locations. For cellular foam insulation tape ALL visible seams with tape matching insulation color.

D. Fiberglass insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms.
3. Finish with glass cloth and vapor barrier adhesive.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Cellular foam insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

1. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms.
2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
3. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

F. Fiberglass insulated pipes conveying fluids above ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. PVC covers are required in all exposed locations.
3. Finish with glass cloth and adhesive.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. For hot piping conveying fluids, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
6. For steam and condensate piping, insulate flanges and unions.

G. Inserts and Shields:

1. Refer to Section 23 05 29 for additional information.
2. Application: Piping 1 inch diameter or larger.
3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
7. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such Armaflex Armafix Insulation Pipe Hangers, are acceptable.

H. Finish insulation at supports, protrusions, and interruptions.

I. For pipe exposed below 10 feet above finished floor, finish with PVC jacket and PVC fitting covers.

J. For piping exposed in mechanical rooms below 10 feet above finished floor, finish with aluminum jacket and aluminum fitting covers.

K. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

L. Install insulation blanket on steam and condensate valves.

M. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.

N. Foam or closed cell insulation on black or galvanized iron pipe operating below ambient temperature is not permitted.

3.3 GLASS FIBER INSULATION SCHEDULE

PIPING SYSTEM:	PIPE SIZE:	THICKNESS:
Heating Water Supply and Return	1-1/2" & smaller	1-1/2"
Heating Water Supply and Return	2" & larger	2"
Chilled Water	All sizes	1”
Heat Recovery Water	All sizes	1”
Air Terminal Unit Reheat Coil Return Bends	1” & smaller	1-1/2”
Steam & Steam Condensate	1-1/2” & smaller	1-1/2”
Steam & Steam Condensate	2" & larger	3"
Condensate Pump Steam Vent	All sizes	1-1/2”
Steam Vent	All sizes	1-1/2”
Piping Exposed to Freezing w/ Heat Tracing (Provide with stainless steel metal jacket in outside conditions)	All sizes	1”

3.4 CELLULAR FOAM INSULATION SCHEDULE

PIPING SYSTEM:	PIPE SIZE:	THICKNESS:
Cold Condensate Drains (below ambient)	All sizes	1"
Refrigerant Suction Line	All sizes	1”
Refrigerant Liquid Line (in spaces 120 degrees and greater)	All sizes	1”
Fan Coil Unit Condensate	All sizes	1”
Chilled Water / Heat Recovery Coil Return Bends	All sizes	1"

END OF SECTION 23 07 19

SECTION 230900 - DIGITAL CONTROL EQUIPMENT

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Equipment provided with factory wired controls shall be coordinated with UNL BSM Controls group as to interconnect compatibility for remote monitoring and/or operation. Systems interconnect shall be by way of BACnet or MODbus signal standards and only with the review and approval of UNL controls engineering staff.

C. Control systems components, such as economizer dampers, automatic control valves, and variable frequency drives, shall be furnished to the project by UNL BSM. The respective contractor shall be responsible for installation of these devices.

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

A. INSTALLATION

1. The control system shall be installed by UNL BSM.
2. The contractor shall mask off and protect all actuators, thermostats, and other controls components during the application of paint and insulation.
1. Variable frequency drives shall be furnished by UNL BSM, installed and wired by Division 26 Contractor.

END OF SECTION 23 09 00

SECTION 23 09 01 - INSTRUMENTS AND CONTROL ELEMENTS

1. GENERAL

1.1 SECTION INCLUDES

A. Control dampers.

B. Control valves.

C. Actuators: control valves and dampers.

D. Electronic sensors.

E. Humidity sensors.

F. Status sensors.

G. Airflow measuring stations.

H. Leak detection sensors.

I. Control wiring.

J. Miscellaneous accessories.

1.2 SYSTEM DESCRIPTION

A. The temperature control system for this project shall utilize all electric relays, actuators, etc. for all controlled devices.

B. Provide complete and operational system of instruments and control elements and accessories as necessary required to operate mechanical systems, fulfill the intent of the plans and specifications and provide operating sequence as specified.

1.3 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. QUALITY ASSURANCE

B. REFERENCES

C. SUBMITTALS

1. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
2. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve.
3. Label each control device with setting or adjustable range of control.
4. All required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Submit leakage and flow characteristics, plus size schedule for control dampers.

D. PROJECT RECORD DOCUMENTS / OPERATION AND MAINTENANCE MANUALS

1. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors and include in Maintenance Manuals. Revise shop drawings to reflect actual installation and operating sequences prior to including in Maintenance Manuals.
2. Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances in Maintenance Manuals.

E. DELIVERY, STORAGE, AND HANDLING

F. WARRANTY

1. Submit manufacturers warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

G. COORDINATION

1. All products listed in this specification section shall be coordinated with other trades prior to installation to ensure that all manufacturer requirements for installation (i.e. inlet/outlet distances, mounting locations, etc) have been satisfied. No additional compensation shall be awarded for controls component relocation due to lack of coordination.

    a. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
    b. Coordinate equipment with Fire Detection and Alarm systems to achieve compatibility with equipment that interfaces with that system.

2. The manufacturer's authorized representative shall review and approve placement for each component location indicated on the plans, prior to installation. A written report shall be submitted to the engineer if any locations do not meet the manufacturer's placement requirements.

1.4 MAINTENANCE SERVICE

A. Provide service and maintenance of control system for one year from Date of Substantial Completion.

B. Provide complete service of controls systems, including call backs. Make minimum of 2 complete normal inspections at start of heating and cooling seasons to inspect, calibrate, and adjust controls, and submit written reports. Coordinate with commissioning plan.

2. PRODUCTS

2.1 CORROSIVE ENVIRONMENTS

A. Where controls components are installed in the fume exhaust air stream, they shall be provided with corrosion-resistant materials and the assembly shall be suitable for its intended service.

2.2 CONTROL DAMPERS

A. Ruskin CD-60 or equal, unless scheduled differently on the Drawings.

1. Damper shall meet the leakage requirements of the International Energy Conservation Code by leaking less than 3 cfm/sf at 1" of static pressure and shall be AMCA licensed as a class 1A damper.
2. Frame: 16 gage galvanized steel structural hat channel with tabbed corners for reinforcement for 11 gage structural equivalence.

3. Blades: 14 gage equivalent thickness galvanized steel, roll-formed airfoil type for low pressure drop and low noise generation. Blade edge seals shall be Ruskinprene type or equivalent suitable for -72 deg F to 275 deg F mechanically locked into the blade edge.

    a. Provide dampers with parallel blades for 2- position control.
    b. Provide opposed blades for modulating control.

4. Jamb seals: flexible metal, compression type to prevent leakage between blade end and damper frame. Blade end overlapping frame is unacceptable.
5. Bearings shall be corrosion resistant, permanently lubricated stainless steel sleeve type turning in a n extruded hole in the damper frame.
6. Axles: Axles shall be hexagonal positively locked into the damper blade.
7. Linkage shall be concealed out of airstream, within the damper frame to reduce pressure drop and noise.

B. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.

2.3 CONTROL VALVES

A. Hydronic Control Valves:

1. Up to 2 inches (50 mm): Bronze body, screwed ends.
2. Over 2 inches (50 mm): lug style butterfly valve, ASTM A 536 ductile-iron body, bronze trim, stainless steel stem, EPDM seat and seal.

B. Pressure Independent Hydronic Control Valves (where scheduled on drawings):

1. Control valves shall be pressure independent. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.
2. The valve bodies shall be of cast iron, steel or bronze and rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass, or bonze.
3. Valves shall be manufactured by or approved equivalent.

2.4 ACTUATORS: CONTROL VALVES AND DAMPERS

A. Exact size and type of actuators shall be determined from valve and damper manufacturer's torque requirements, close off ratings, etc.

1. All control valves and control valve operators must be able to close valves against pump shut off head, or a minimum 100 psig close-off rating.

B. All damper operators must be able to close dampers against fan shut off pressure. Provide sufficient number of damper operators to achieve unrestricted movement throughout damper range. Provide one damper operator for maximum 36 sq ft of damper section.

C. Provide actuators with "normally open" or "normally closed" spring return positions as required by operation sequence or as required for freeze, fire, temperature protection.

D. Actuators shall be powered either by 24 or 120 VAC as required. All power actuator wiring by Temperature Controls Contractor. Actuator must have built-in overload protection to prevent damage to actuator when damper reaches its end position. End switches are not acceptable. Provide 3 ft. cable for connection to a junction box.

E. A manual release shall be provided on the actuator body.

F. The actuator must be designed for a minimum life of 60,000 full cycles at full torque.

G. The actuator must have the capability of adding an auxiliary switch or feedback potentiometer if required.

H. Manufacturer shall warranty all actuators for a minimum of two years from the installation date.

2.5 ELECTRONIC SENSORS

A. WALL MOUNTED CARBON DIOXIDE SENSOR

1. Carbon dioxide sensor shall be wall mounted with non-dispersion-infrared technology for sampling, integrated temperature sensor. Measurement range shall be 0-3,000 ppm range with an accuracy of +/- 50 ppm or +/- 5% whichever is greater. 14°F to 140°F temperature range. LED display at sensor for status information. The annual sensor drift shall 20 ppm so that re-calibration is not required for five years. 0-10 VDC output to EMCS. Carbon dioxide sensor shall be Honeywell model C7242A or equivalent.

B. TEMPERATURE SENSORS: RTDs AND TRANSMITTERS

1. Room Thermostats: Temperature sensor shall have as minimum, integral linearized 20K ohm nickel thermistor, +/- 1°F accuracy from 45° to 95°F, setpoint adjustment with degrees F absolute (where applicable), occupied/unoccupied override and white case.

a. Setpoint adjustment shall only be provided in the following spaces:

1) Offices and conference rooms throughout the facility.

b. Where setpoint adjustment is provided, it shall be limited to a range of +/- 5 deg F of the heating and cooling setpoints.
c. The room sensors for all other spaces shall not include setpoint adjustment capabilities.

2. Immersion and Airstream Temperature Sensors:

a. Resistance nickel temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
b. Measuring current maximum 5 mA with maximum self-heat of 0.031 degrees F/mW in fluids and 0.014 degrees F/mW in air.
c. Provide 3 lead wires and shield for input bridge circuit.
d. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements in larger ducts or as indicated or specified. Use sensor length of 8 feet or 16 feet as required.
e. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches. Provide extra brass socket directly adjacent to sensor socket for system calibration.
f. Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.

3. Electric, Low-Limit Duct Thermostats:

a. Snap-acting, single pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal or below set point.

1) Unless otherwise noted on drawings, initial setpoint shall be 35 deg F.
2) Bulb Length: Minimum 20 feet.

3) Quantity: One thermostat for every 20 sq. ft. of coil surface.
4) Low-limit duct thermostats shall be Johnson Controls model A70HA-1 or approved equal.

C. HUMIDITY SENSORS

1. Elements: Contamination resistant, capable of ±2% RH accuracy, have field adjustable calibration and provide a linear proportional signal.
2. Room Sensors: With locking cover, matching room temperature sensors used, span of 20 to 80 percent relative humidity.
3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.

D. PRESSURE TRANSMITTERS / TRANDUCERS

1. Static Pressure Trasmitters: Nondirectional sensor with suitable range for expected input (not exceeding 150 percent of maximum expected input), and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
b. Output: 4 to 20 mA.
c. Building Static-Pressure Range: 0 to 0.25 inch w.g.
d. Duct Static-Pressure Range: 0 to 5-inch w.g.

1) Verify that range is appropriate for anticipated static pressures when installed in Air-Handling Equipment.

2. Water Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig operating pressure and tested to 300 psig; linear output 0 to 10 VDC proportional to differential pressure, compatible with the BAS.

a. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of +/- 50 psid. Accuracy shall be +/- 0.25% full scale with a compensated temperature range of 30 to 150 deg F and a maximum working pressure of 250 psig. Install transmitter in a pre-manufactured bypass valve assembly with shut-off valves, vent valves and a bypass valve, all enclosed in a NEMA 1 enclosure.
b. Setra model 230 with Kele model BVA-5 bypass valve assembly, or equivalent.

4. Differential Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA

2.6 STATUS SENSORS

A. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current, with LED indicator. Current sensors on motors equipped with VFDs must be capable of detecting status down to 6Hz. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty. Provide multiple wraps of wiring on motors 1 hp or less in order to increase signal strength.

2.7 LEAK DETECTION SENSORS

A. Buna-N float, stainless steel housing, 2 sensor wire, Gems Sensors Series DLP-2 or equivalent.

3. EXECUTION

3.1 INSTALLATION

A. Control Wiring:

1. Install electrical components and use electrical products complying with requirements of applicable Division-16 sections of these specifications. Mount equipment at convenient locations and heights. Do not mount any panels or other electronic equipment such that it is attached to vibrating equipment such as air handling units.
2. The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices.
3. Install complete control wiring system for control systems. Coordinate with other trades such that control wiring, transformers, and all other required items are provided and installed for all required components.
4. All control wiring exposed or installed in mechanical rooms/penthouses shall be run in conduit. Provide flexible conduit at connections to actuators and other controlled devices.
5. Concealed control wiring routed above acoustical ceiling is not required to be in conduit if allowed by code, but wire must be plenum rated. Clip wire to structural ceiling. All wiring to be run at right angles to building.
6. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
7. Low voltage control wiring shall be run in separate conduit from line voltage power wiring.
8. Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system.

B. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

D. Ensure installation of components is complementary to installation of similar components.

E. Install in accordance with manufacturer’s instructions.

F. All devices shall be mounted appropriately for the intended service and location.

G. Check and verify location of thermostats, humidity sensors and other exposed control sensors with plans and room details before installation. Locate 60 inches above floor on sensors without setpoint adjustment; locate at 48 inches above floor on sensors with setpoint adjustment. Align with lighting switches.

H. Mount outdoor sensors indoors, with sensing elements outdoors and sun shield.

I. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.

J. Provide separable sockets for liquids and flanges for air bulb elements.

K. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

L. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

M. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

N. Do not install controls components in areas below items which may potentially leak.

O. Install steam pressure sensors in locations shown on drawings.

P. Install hydronic pressure sensors on each hydronic system in locations shown on drawings.

3.2 CALIBRATION AND RECALIBRATION

A. Calibrate instruments.

B. Make three-point calibration test for both linearity and accuracy for each analog instrument.

C. Calibrate equipment and procedures using manufacturer's written recommendations and instructions manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

D. Flow:

1. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
2. Manually operate flow switches to verify that they make or break contact.

E. Pressure:

1. Calibrate pressure transmitters at 0. 50, and 100 percent of span.
2. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

F. Temperature:

1. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
2. Calibrate temperature switches to make or break contacts.

G. Stroke and adjust control valves and dampers without positioners, following manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

H. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

I. Provide diagnostic and test instruments for calibration and adjustment of system.

J. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

K. At substantial completion, the contractor shall calibrate all humidity sensors according to the factory recommendations and demonstrate calibration of the sensor to the owner's representative. At the end of the one year warranty, the control contractor shall recalibrate all humidity sensors.

SECTION 23 09 01 - INSTRUMENTS AND CONTROL ELEMENTS

END OF SECTION 23 09 01

SECTION 23 09 93 - SEQUENCE OF OPERATION FOR HVAC CONTROLS

1. GENERAL

1.1 This specification section is a narrative which describes the control logic by which HVAC controls should operate. It describes operation sequences for controls provided by UNL BSM as well as those controls that are “stand-alone” and not part of UNL’s Building Automation System (BAS).

2. PRODUCTS (NOT USED)

3.

3.1

3.2 All control set points called out shall be adjustable through software.

3.3 Refer to drawings for sequences of operation.

END OF SECTION 23 09 93

SECTION 23 21 13 - HYDRONIC PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Above grade pipe, fittings, and joints for :

1. Heating water piping systems.
2. Chilled water piping systems.
3. Equipment drains and overflows.

B. Valves.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

1. Provide welding certifications for all welders on the project.

D. Operation and maintenance manuals.

E. Project record documents.

1. Record actual locations of valves.

F. Delivery, storage, and handling.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Where connecting ferrous and non-ferrous piping materials, use full-port ball valves with bronze construction or a galvanized steel dielectric nipples with plastic liner to separate piping materials.

D. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers or as shown on plans.

E. Use ball or butterfly valves for throttling, bypass, or manual flow control services or as shown on plans.

F. Use lug end butterfly valves to isolate equipment.

1.4 REGULATORY REQUIREMENTS

A. Conform to International Mechanical Code for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state and local labor regulations.

C. Welders shall be certified using AWS testing methods. .

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.6 EXTRA MATERIALS

A. Provide two repacking kits for each size and valve type.

2. PRODUCTS

2.1 STEEL PIPING, FITTINGS, AND JOINTS

A. Applicable Systems

1. Heating water
2. Chilled water

B. Pipe: ASTM A53, Schedule 80, black steel.

C. Fittings (2” and smaller): Malleable Iron: ASTM B16.3, Class 150, threaded or Cast Iron: ASTM B16.4, Class 125, threaded.

D. Fittings (2-1/2” and larger): ASTM B16.9, steel butt weld fittings. Bushings are not permitted, use standard reducing fittings.

E. Joints (2” and smaller): Threaded. Joint compound must be rated for propylene glycol usage.

F. Joints (2-1/2” and larger): AWS D1.1, welded.

G. Branch Tees: Weld-O-Lets and Thread-O-Lets are acceptable for branch piping when main piping is 1" or larger than branch piping.

H. Saddle Tees: Are acceptable for branch piping when main piping is 2" or larger than branch piping.

I. Unions (2” and smaller): 150 psig malleable iron, threaded.

J. Flanges (2-1/2” and larger): 150 psig forged steel, slip-on, 1/16 inch thick preformed neoprene gaskets.

2.2 COPPER TUBING, FITTINGS, AND JOINTS

A. Applicable Systems

1. Heating water
2. Chilled water
3. Equipment drains and overflows

B. Pipe: ASTM B88, Type L, hard drawn

C. Copper Tubing: ASTM B88, Type DWV, hard drawn piping on equipment drains and overflows only.

D. Fittings and Unions (2" and smaller): ASME B16.22 wrought copper and bronze:

1. Solder filler metals: ASTM B32, lead-free alloys.
2. Flux: ASTM B813, water-flushable.

E. Joints (All sizes):

1. Copper to copper: AWS A5.8/A5.8M, BCuP-5 (15% silver), Copper-phosphorus alloy.
2. Copper to bronze or steel: AWS A5.8/A5.8M, BAg-1, Silver alloy (45% silver), non-corrosive flux..

F. Flanges (2-1/2" and larger): Bronze, 1/16 inch thick preformed neoprene gaskets.

2.3 DIELECTRIC NIPPLE

A. Electroplated steel nipple, complying with ASTM F 1545 and IAPMO PS 66.

1. Rated for 300 psig at 225 deg F.
2. Male threaded or grooved end connections.
3. Inert and noncorrosive propylene lining.

2.4 VALVES

A. CALIBRATED BALANCE VALVES

1. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.
2. Valve Design and Construction. All valves shall have a calibrated orifice or venturi section, two ¼" threaded pressure tap ports with integral seals, and memory stop to retain the set position. Valves should be rated for 125 psig working pressure and 250 Deg. F maximum operating temperature.
3. Valves shall be selected based on flowrate, not on pipe size dimensions.
4. Preformed Insulation. All valves to be provided with molded insulation to permit access for balance and read-out.

B. BALL VALVES

1. Up To and Including 2 Inches:

a. Bronze two piece body, stainless steel full-port ball on all systems, Teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends. Include stem extensions on valves used in insulated piping systems.

C. BUTTERFLY VALVES

1. 2-1/2 Inches and Larger:

a. Body: Cast or ductile iron with resilient replaceable EPDM seat, lug ends, extended neck.
b. Disc: Aluminum bronze on closed systems and stainless steel on open systems.
c. Stem: Stainless steel, extended on insulated systems as required to allow valve operation without damage to the insulation.
d. Operator (4" and smaller): 10 position lever handle with memory stop, gear drive.
e. Operator (6" and larger): Handwheel, gear drive.

f. Chainwheel: On valves 6" and larger and installed higher than 8-feet above finished floor, provide sprocket rim, brackets, and chain compatible with valve.

D. SWING CHECK VALVES

1. Up To and Including 2 Inches:

a. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.

2. Over 2 Inches:

a. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

E. SPRING LOADED CHECK VALVES

1. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

3. EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends to full inside diameter using tools designed for this purpose. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION

A. Where connecting ferrous and non-ferrous piping materials, use full-port ball valves with bronze construction or a galvanized steel dielectric nipples with plastic liner to separate piping materials.

B. Heating water connections to terminal units shall be copper (no steel).

C. Install all piping in accordance with ASME B31.9.

D. Route piping in orderly manner, parallel to building structure, and maintain gradient.

E. Install piping to conserve building space, and not interfere with use of space.

F. Group piping whenever practical at common elevations.

G. Sleeve pipe passing through partitions, walls and floors.

H. Slope piping and arrange to drain at low points.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

J. Refer to Section 23 05 29 and Section 23 05 48 for installation of supports and hangers.

K. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.

L. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with General Contractor and requirements of Section 23 05 00.

M. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

N. Install unions on both sides of each control valve and on one side of all other valves. Install unions on the equipment side of final connections to each piece of equipment. Unions are not required at flanged valves or equipment.

O. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

P. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

Q. Install valves with stems upright or horizontal, not inverted.

R. Provide insulated valve stem extensions on all valves installed in insulated piping systems.

S. Install chainwheel operators on valves 4" and larger that are installed 8-feet above finished floor or greater. Extend chain down to maximum 5-feet above finished floor.

T. Pipe connections shall be installed with the branch piping connected to the top of the main/header. If this is not possible due to space constraints, a connection with the same vertical centerline is acceptable. Connections to the bottom of the main/header is not allowed.

U. Provide solid chrome plated steel escutcheons cover the sleeves and openings at walls and ceilings in exposed areas.

3.3 SYSTEM FLUSHING, FILLING, PRESSURE TESTING AND CLEANING

A. Flush, fill, pressure test and clean all new hydronic systems and parts of existing systems which have been altered, extended or repaired.

B. Flush and fill systems with all valves open to coils. Bleed air from coils and piping. Clean strainers. Refer to Section 23 25 00.

C. Pressure Test Procedure:

1. Submit copy of pipe pressure test log for each section of piping tested. Refer to 23 05 00 for general pipe pressure testing requirements (i.e., test pressure gages, inspections, etc.).
2. Leave joints including welds uninsulated and exposed for examination during the test.
3. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

6. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test.
7. After the hydrostatic test pressure has been applied for at least 12 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

D. Clean systems. Refer to Section 23 25 00 for cleaning procedure.

END OF SECTION 23 21 13

SECTION 23 21 16 - HYDRONIC SPECIALTIES

1. GENERAL

1.1 SECTION INCLUDES

A. Strainers.

B. Relief valves.

C. Flexible connections.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Project record documents

1. Record actual locations of hydronic specialties.

D. OPERATION AND MAINTENANCE DATA

1. Furnish service and maintenance of glycol system for one year from date of substantial completion.
2. Monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.
3. Provide full laboratory analysis of fluid at 6 months and 12 months from the date of substantial completion.

E. QUALIFICATIONS

F. DELIVERY, STORAGE AND HANDLING

2. PRODUCTS

2.1 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8inch brass needle valve at top of chamber.

B. High Capacity Float Type:

1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

C. Washer Type:

1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.2 STRAINERS

A. Size 2 inch and Under:

1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch Type 304 stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:

1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch Type 304 stainless steel perforated screen.

C. Size 5 inch and Larger:

1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch Type 304 stainless steel perforated screen.

D. Provide blowdown valves where shown on plan.

2.3 SAFETY RELIEF VALVES

A. Cast iron or Bronze body, EPDM seat, brass internal parts, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.4 FLEXIBLE CONNECTIONS

A. Spherical, Rubber, Flexible Connectors:

1. Body: Peroxide-cured EPDM synthetic rubber and Kelvar tire cord reinforcement.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Control Rods: Steel with oversized washers and rubber bushings.
4. Performance: Capable of misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.
7. Manufacturer: Mason Industries model Safeflex or equivalent.

B. Stainless steel braided connection with steel flange rated for 225 psig and 16" Hg vacuum. Operating temperature 20 degrees F. to 240 degrees F.

C. Minimum allowable movement shall be as follows:

Lateral Deflection	1/2"
Elongation	3/8"
Compression	1/2"
Angular Deflection	15 degrees

3. EXECUTION

3.1 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions and as shown on drawings.

B. Provide manual air vents at all system high points and in accessible locations. Provide automatic air vents where shown on drawings / details.

C. Provide drain valves at all low points and in accessible locations.

D. Provide heat trap piping arrangement for all expansion tanks as shown on drawings or per manufacturer instructions.

E. Provide appropriately sized structural supports for air/dirt separators. Support air/dirt separator independently of piping system for larger sizes per manufacturer's instruction.

F. Provide valved drain and hose connection on strainer blow down connection.

G. Triple-duty valve are not allowed. Provide separate shut-off, check and balancing valve.

H. Provide flexible connectors on pump suction and discharge.

I. Provide flexible connectors on all pipe connections that serve vibration isolated mechanical equipment.

J. Provide full-size piping from relief valve outlet to nearest floor drain. In glycol systems, provide full-size piping from relief valve to glycol feeder.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

L. Clean and flush glycol system before adding glycol solution. Refer to Section 23 25 00.

M. Feed glycol solution to system through glycol feeder make-up line with pressure regulator, venting system high points.

N. Perform tests determining strength of glycol and water solution and submit written test results.

O. Alignment-Guide and Anchor Installation

1. Install alignment guides to guide expansion and to avoid end-loading and torsional stress. Coordinate with expansion joint manufacturer recommendations as required.
2. Attach guides to pipe and secure guides to building structure.
3. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
4. Anchor Attachments:

    a. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
    b. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
    c. Anchor Attachment to Steel Structural Members: Attach by welding.
    d. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
    e. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 21 16

SECTION 23 21 23 - HVAC PUMPS

1. GENERAL

1.1 SECTION INCLUDES

A. Closed-coupled, in-line centrifugal pumps.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Performance requirements.

1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within $\pm$ 10 percent of scheduled performance and published operating curve.

C. Submittals.

D. Operation and maintenance data.

E. Qualifications.

F. Delivery, storage and handling.

G. Extra materials.

1. Provide one set of mechanical seals and gaskets for each pump.

2. PRODUCTS

2.1 CLOSED-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. See pump schedule on drawings for performance requirements.

B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psig maximum working pressure.

C. Casing: Cast iron, with flanged pump connections.

D. Impeller: ASTM B 584 Dynamically balanced bronze, keyed to shaft. For constant speed pumps, trim impeller to match specified performance.

E. Bearings: Two, oil lubricated bronze.

F. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.

G. Seal: Mechanical Carbon rotating against a stationary ceramic seat, 250 degrees F maximum continuous operating temperature.

H. Drive: Flexible coupling.

3. EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

C. Provide automatic condensate pump unit at each location where gravity drainage is not possible. Coordinate with other trades.

D. Install check valve and gate or ball valve on each condensate pump unit discharge.

E. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

F. Provide line sized shut-off valve and pump suction fitting, flexible connection on pump suction, and line sized soft seat check valve, balancing valve, flexible connection and line sized shut-off valve on pump discharge. Refer to piping schematics and details.

G. Provide air cock and drain connection on horizontal pump casings.

H. Install base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 23 05 00.

I. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

J. Support pump fittings with floor mounted pipe and flange supports.

K. Install valves that are the same size as piping connected to pumps.

L. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

3.3 START-UP AND COMMISSIONING

A. Start-up pump in accordance to manufacturer written instructions.

B. Before and after start-up, perform the following preventative maintenance operations and checks:

1. Lubricate bearings.
2. Check, align and certify alignment of base mounted pumps prior to start-up.
3. After pump is started, check for proper rotation, proper mechanical operation and motor load to ensure that pump is not overloaded. Close pump balancing valve as required to bring pump motor load within motor nameplate data.
4. Check pumps to ensure it is not air bound or cavitating.
5. After sufficient run time, remove, check and clean strainer as required. Repeat cleaning strainer until system is sufficiently flushed. Refer to Section 23 25 00, Chemical Water Treatment.
6. After completing start-up, replace pump strainer with permanent strainer.

C. Coordinate pump testing, adjusting and balancing with UNL Balancing / Commissioning Team. Complete additional preliminary work as required.

SECTION 23 21 23 - HVAC PUMPS

END OF SECTION 23 21 23

SECTION 23 31 13 - DUCTWORK

1. GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

B. Sheet metal plenums.

C. Duct cleaning.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

1. See Section 23 51 00 for information related to kitchen grease ducts and generator engine exhaust.

B. Performance requirements.

1. No variation of duct configuration or sizes shall be permitted except by written permission.

C. Submittals.

1. Submit detailed CAD-generated ductwork drawings at minimum ¼" scale, with details of the following:

a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
b. Duct layout indicating pressure classification and sizes on plans.
c. Seam and joint construction.
d. Penetrations through fire-rated and other partitions.
e. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

NOTE: No installation of ductwork shall be allowed until detailed shop drawings have been reviewed by the Engineer. Any ductwork that is installed prior to the Engineer's review of the shop drawings shall be subject to removal and replacement at the Contractor's expense.

D. Project record documents.

1. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

E. Quality assurance.

1. Perform Work in accordance with the following standards:

a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
c. NFPA 91 - Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
d. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
e. SMACNA - HVAC Air Duct Leakage Test Manual.
f. SMACNA – HVAC Duct Construction Standards - Metal and Flexible.

g. SMACNA - Round Industrial Duct Construction Standards
h. International Mechanical Code, current edition.

F. Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
2. Installer: Company specializing in performing the work of this section with minimum five year's experience.

G. Regulatory requirements.

1. Construct all ductwork per codes listed in section 1.2.E

1.3 Environmental requirements.

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

2. PRODUCTS

2.1 MATERIALS

A. Galvanized Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90. Provide mill-phosphatized finish for surfaces of ducts exposed to view.

B. Stainless Steel Ducts: ASTM A 480/A 480M, Type 316 sheet form with No. 4 finish for surfaces of ducts exposed to view, and Type 304 sheet form with No. 1 finish for concealed ducts.

C. Steel Ducts: ASTM A366.

D. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061- T6 or of equivalent strength.

E. Insulated Flexible Ducts:

1. UL 181, Class 1, mechanically-locked spun nylon fabric supported by helically wound spring steel wire; fiberglass insulation; fire retardant polyethylene vapor barrier film.
2. Pressure Rating: 6 inches WG positive, 5.0 inches WG negative (through 16" diameter), 1.0' WG negative (18" to 20").
3. Maximum Velocity: 5500 fpm.
4. Temperature Range: -20 degrees F to 250 degrees F.
5. Minimum Sound Attenuation Performance (Insertion Loss in dB of 12' Length of 12" Round Duct):

a. 63 Hz Octave Band: 13
b. 125 Hz Octave Band: 37
c. 250 Hz Octave Band: 31
d. 500 Hz Octave Band: 34
e. 1 kHz Octave Band: 37
f. 2 kHz Octave Band: 47
g. 4 kHz Octave Band: 34

6. Manufacturer: Flexmaster Type 6B or equivalent.

F. Fasteners: Rivets, bolts, or sheet metal screws.

G. Joint & Seam Sealant: Shall be a flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air, and moisture into the duct system. Sealer shall be UL 723 listed and meet NFPA requirements for Class 1 ductwork. VOC shall be <75 g/l.

1. Solids Content: Minimum 65 percent.
2. Shore A Hardness: Minimum 20.
3. Mold and mildew resistant.
4. Service: Indoor or outdoor.
5. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
6. Manufacturer: Ductmate Industries PROseal or equivalent.

H. Hanger Rod: ASTM A36; steel or galvanized, threaded.

2.2 SHOP FABRICATED DUCTWORK

A. Fabricate, reinforce and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Construct T's, and elbows in accordance with SMACNA HVAC Duct Construction Standards-Metal and Flexible, latest edition, using radius of not less than 1-1/2 times width of duct on centerline. Where mitered rectangular elbows are used or indicated, provide dual wall airfoil turning vanes.

C. Reference SMACNA figure 2-9 to construct gradual transitions where ductwork changes size or offsets.

2.3 MANUFACTURER FABRICATED DUCTWORK

A. Fabricate, reinforce and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Round and oval duct shall be spiral lockseam duct with light reinforcing corrugations unless indicated otherwise.

C. Construct T's, bends, and elbows with minimum bend radius elbows shall be 1.5 times the duct diameter (major or minor axis on oval ductwork depending on direction of bend). Where not possible and where mitered elbows are used or indicated, provide double wall airfoil turning vanes.

D. Fabricate round and oval duct; fittings in accordance with SMACNA Standards. Joints shall be minimum 2 inch insertion length for joint connections.

E. Weld ductwork is to be weld with filler rod of the same material as the metal that is being welded. Coat welded joints with protective paint to prevent damage to galvanized surfaces.

F. On round and oval ducts, provide 45 deg wye tee take-offs or 90 deg conical tee take-offs or 45 degree low loss entry tee take-offs or other fitting as indicated on plans. Straight taps are not acceptable.

2.4 TRANSVERSE DUCT CONNECTION SYSTEM – RECTANGULAR DUCT

A. Slide on flange system: Ductmate and Ductmate WDCI connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Gasket material shall be chemical resistant material in all fume exhaust ductwork.

B. Formed on flange system: TDC, TDF or equivalent connection system or equivalent. Such flanges shall be constructed as SMACNA T-24 flange (Page 1-25 and 1-37 '85 SMACNA Duct Construction Manual, 1985 Edition).

2.5 TRANSVERSE DUCT CONNECTION SYSTEM – ROUND AND OVAL DUCT

A. Slip type connector: Keating coupler.

B. Slide on flange system. Spiralmate and Ovalmate connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

C. Formed on flange system: Factory-applied Van Stone connection on one end of the duct with field-applied Van Stone connecter on the other end of the duct. Provide factory-applied Van Stone connections on each end of fittings.

2.6 LOUVER BACKPAN

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.

B. Construct of 18-gage galvanized steel using continuous external welded joints.

C. Welded ductwork is to be welded with filler rod of the same material as the metal that is being welded. Prime coat and paint welded joints with cold galvanized paint.

D. Slope bottom to prevent accumulation of water. Provide drains as necessary.

2.7 DOUBLE WALL, PRE-MANUFACTURED SHEET METAL PLENUMS (OUTSIDE AIR PLENUM, RELIEF AIR PLENUM)

A. General: Double wall, insulated pressurized plenum equipment shall be provided as indicated on the drawings. All panels and components shall be prefabricated and supplied by a nationally recognized manufacturer with published standards of construction, assembly and technical performance. Provide plenum as manufactured by McGill Airflow or equivalent.

B. The entire plenum installation shall be designed by the plenum manufacturer to be self-supporting. Where roof spaces or loading require additional strength, it shall be provided by heavier panel skins, additional structural members and necessary pipe columns. The installer shall furnish and install all such additional structural members according to the drawings and details furnished by the plenum manufacturer.

C. The finished plenum shall be able to withstand a positive internal static pressure of 4" and a negative internal static pressure of -4". Under these static conditions, the assembled structure shall not exhibit any panel joint deflections in excess of L/200 where L is the unsupported span length of any panel section within the completed plenum.

D. Joint Construction: Snap-lock type with continuous self locking joint on both inside and outside of panel surface.

E. All panels shall be 4" thick with solid galvanized exterior shell and a solid galvanized interior shell as noted on the drawings and mechanical equipment schedule.

F. Outer shall be constructed of minimum 18-ga. galvanized sheet metal. Inner shell shall be constructed of minimum 22-ga. galvanized solid sheet metal.

G. Assembly Trim: Minimum 18-ga. hot-dipped galvanized steel furnished in standard lengths to be field cut.

H. All perimeter and longitudinal steel channel shall be constructed of ASTM Type A-446 structural quality galvanized steel with a minimum of 18 gage thickness or ASTM Type A-526 galvanized steel with a minimum of 16 gage thickness.

I. Each panel assembly shall be completely filled acoustical/thermal insulating material that is inert, mildew and mold resistant as well as vermin proof. Insulation shall have a flame spread rating of 25 and smoke developed rating of 50.

J. Thermal Performance: Insulating materials shall have a maximum thermal conductance of 0.06 Btu / Hr per square foot per Deg F (@ 75 Deg F mean temperature).

K. Personnel Access Doors: Provide personnel access doors where shown on the plans. Door sizes shall be 36”W x 66”H. All access door panels and doors shall be constructed of 18-ga. solid galvanized steel inner liner and galvanized outer shell. Each door shall have a minimum of two ball bearing hinges and two wedge-lever door handles. All levers shall be operable from inside or outside the casing. Door swings shall be as indicated on the plans. Doors shall seat against neoprene gasket material, installed around entire perimeter of door. Provide 12" square viewing windows which are composed of double-glazed layers of wire reinforced safety glass separated by an air space and sealed with rubber seals.

L. Plenum construction shall be fully coordinated with other trades to accommodate walls, floor, structure, piping, and other components in the vicinity. All penetrations and joints shall be sealed airtight.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions; SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition and International Mechanical Code requirements.

B. All ductwork shall be stored, installed, and maintained per the “Intermediate Level” as defined by SMACNA Duct Cleanliness for New Construction Guidelines, current edition. Acceptable cleanliness shall be verified by UNL BSM prior to air distribution system operation.

C. Seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition.

D. Drawings indicate general arrangement of ducts, fittings, and accessories.

E. Construct and install each duct system for the specific duct pressure classification indicated.

F. Install round in lengths not less than 12 feet, unless interrupted by fittings.

G. Install ducts with fewest possible joints.

H. Install fabricated fittings for changes in directions, changes in size and shape, and connections.

I. Install only low loss high efficiency fittings at takeoffs. Extractors not allowed.

J. Install couplings tight to duct wall surface with a minimum of projections into duct.

K. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.

L. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

M. Install ducts with a clearance of 2 inch, plus allowance for insulation thickness.

N. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

O. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

P. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

Q. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

R. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Firestopping."

S. Verify location of air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to reflected ceiling plans, finish schedule, material finish specification, and shop drawings.

T. Coordinate routing with all other trades to establish space requirements for each.

U. Contractor may vary route and shape of ductwork and make offsets during progress of work if required to meet structural or other interferences. Where such changes impair the system performance, the changes will be corrected at Contractor’s expense.

V. All ductwork shall be substantially and neatly supported on galvanized steel straps or angles riveted or bolted to duct flanges and properly anchored to the construction so that horizontal ducts are without sag or sway, vertical ducts are without buckle, and all ducts are free from the possibility of deformation, collapse or vibration. Support at each joint and at 4 feet on center maximum.

W. Openings required for ductwork through structural elements in new construction shall be coordinated with the General Contractor. Shop drawings locating such openings shall be prepared in ample time to meet the construction schedule.

X. Provide sleeves at all duct penetrations through walls, floors and roofs. Openings through sound-rated partitions shall have annular space stuffed with fiberglass insulation for full thickness of wall.

Y. Provide 2-inch deep bitumastic coated drip pans on all non-ducted hoods, fans or penthouses used for relief or exhaust air service. Pans shall be 12 inches larger all around than roof opening with clear vertical openings between pan and structure as indicated. Insulate pan where indicated.

Z. Install automatic control dampers as recommended by the manufacturer.

AA. Prevent passage of unfiltered air around filters with felt, rubber, neoprene gaskets, or other approved safing material.

BB. Provide openings in ductwork to accommodate thermometers and controllers. Provide pitot tube openings for testing of systems, complete with metal cap with spring device or screw to prevent air leakage.

CC. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

DD. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Keep openings covered until ready for continuing duct run or final connections.

EE. Paint ductwork visible behind wall-mounted air outlets and inlets matte black.

FF. Change duct sizes gradually, not exceeding 30 degrees divergence and 20 degrees convergence. Blunt transitions are not acceptable.

GG. Use crimp joints with or without bead for joining round duct sizes 8 inches and smaller and install with crimp in direction of air flow.

HH. Provide closure flanges around exposed ductwork at wall and ceiling penetrations, 1-1/4 inches wide minimum.

II. Provide flexible connect between ductwork and all moving equipment.

1. Provide 1-inch slack for free movement.

JJ. Join VAV boxes to medium pressure supply duct mains with minimum straight length of duct equal to 5 times box inlet diameter size. Duct to be rigid and the same size as VAV box inlet. Flexible ductwork is not allowed to join boxes to supply duct main.

KK. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction".

Threaded cap test holes shall be provided in all ductwork. Test holes shall be installed after the reheat coil in all VAV boxes. Provide extensions to allow for insulation thickness. Test holes shall be "Ventlok" or equal.

3.2 GENERAL

A. Install in accordance with manufacturer's instructions; SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition and International Mechanical Code requirements.

B. Seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition.

C. Duct sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

D. Provide openings in ductwork where required to accommodate thermometers and controllers.

E. Do not allow round duct to be fitted to oval by deformation alone. A round-to-oval transition must be used.

F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

G. Cover all exposed fiberglass insulation with duct tape.

H. During construction provide temporary closures of metal or tape polyethylene on open ductwork to prevent construction dust from entering ductwork system.

I. Connect flexible ducts to metal ducts with stainless steel bands with worm gear tightener, nylon bands are unacceptable.

J. Duct transition from round to rectangular and vise versa shall be made with rectangular to round duct transition fitting.

K. Provide flange-type joint at transverse joints or seal as specified. All transverse joints shall be inspected by the Owner prior to insulating ductwork.

L. Duct work upstream of air terminal units shall be rigid duct with minimum three diameters of straight ductwork upstream of air terminal units.

M. Air terminal take-offs from rectangular main ducts shall be lo-loss 45°F take-offs, extractors are not allowed.

N. Diffusers and register take-offs from rectangular duct mains shall be lo-loss 45° fittings, with integral balancing damper that is provided with stand-off bracket and quadrant lock. Extractors are not allowed.

O. A maximum length of 3’ of flexible duct is allowed upstream of each diffuser or grille. See details on Drawings.

P. Exhaust grille/register branch duct connections to rectangular mains shall be lo-loss 45° entry fittings with integral balancing damper.

Q. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

R. Plenum construction shall be fully coordinated with other trades to accommodate walls, floor, structure, piping, and other components in the vicinity. All penetrations and joints shall be sealed airtight.

3.3 INSTALLATION OF 2" AND GREATER PRESSURE CLASS DUCTWORK (POSITIVE OR NEGATIVE PRESSURE)

A. All round and oval duct elbows installed shall be die-formed, gored, pleated or mitered. All mitered elbows shall be equipped with turning vanes.

B. On round and oval ducts, provide 45 deg wye or 90 deg conical tee take-offs as indicated on plans. Straight taps are not acceptable.

C. All diverging flow fittings shall be constructed such that no excess material projects from the body into the branch tap entrance.

D. Transverse joints of all rectangular ducts greater than 24" wide or deep shall be fabricated with flanging system as called out previously (Ductmate or equivalent).

3.4 INSTALLATION OF 1" AND LESS PRESSURE CLASS DUCTWORK (POSITIVE OR NEGATIVE PRESSURE)

A. All round duct elbows installed shall be of the adjustable, die-formed, gored, pleated or mitered type. All adjustable elbows shall be sealed after installation.

B. All mitered elbows shall be equipped with turning vanes.

C. Connect ceiling diffusers to low pressure ducts with adjustable elbow at duct and short length of flexible duct held in place with strap or clamp. Do not use flexible duct to change direction. Connection detail as well as maximum length of flex duct allowed to diffusers is indicated on the plans.

3.5 PLENUMS

A. General

1. Unless otherwise noted, mount casings on 4-inch high concrete curbs.

3.6 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. Exposed ductwork serving ventilated workstations and corrosive storage cabinets:

1. Install the exposed stainless steel ductwork serving the ventilated workstations with the longitudinal weld facing the adjacent wall and away from public view. If possible, install one continuous exposed duct without transverse joints. Install escutcheon ring at ceiling penetration. Ring shall be same material and same finish as exposed duct. Note that exposed ductwork shall be provided with a No. 4 finish. Verify acceptable appearance of installed ductwork with Architect after installation.

3.7 CLEANING

A. The air handling units, energy recovery wheel, exhaust fans, and other HVAC airside equipment shall not be used for temporary building conditioning without the written permission from the Owner and Architect/Engineer. Open ductwork that has been installed shall be protected during the duration of the project with polyethylene plastic and duct tape over the open ends. Uninstalled ductwork shall be protected from construction dust by covering the uninstalled ductwork with polyethylene plastic. Prior to installing ductwork, the inside of the ductwork shall be wiped down or vacuumed.

B. Clean inside all air handling units, energy recovery units, and outside air duct systems before the fans are turned on. Call for inspection by the owner's representative to verify that all ducts are cleaned. If the ductwork is unacceptable, the contractor shall provide vacuuming of these duct systems by forcing air at high velocity through duct where manual cleaning in not possible due to duct lengths or size. Call for re-inspection by Owner's representative.

C. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

D. Call for inspection by Owner's representative.

E. Install a fresh set of filters in all equipment immediately prior to project turnover.

3.8 DUCTWORK SCHEDULE

Duct System:	Material:	Longitudinal Joints:	Transverse Joints:	Pressure Class:	Sealant Class:	Leakage Class:	Additional Notes:
Outside air system upstream of AHU	Galv. Steel	3A	4A, 4C	-2"	B	24	
Rectangular SA system upstream of terminal units	Galv. Steel	3A, 3E	4A, 4C, 4D	+4"	A	6	8B
Round SA system upstream of terminal units	Galv. Steel	3C, 3E	4B, 4D	+4"	A	3	8B
Rectangular SA system downstream of terminal units	Galv. Steel	3A, 3B, 3E	4A, 4C, 4D	+2"	A	24	8B
Round SA system downstream of terminal units	Galv. Steel	3C, 3E	4B, 4D	+2"	A	12	8B
Rectangular general EA or RA system upstream of terminal unit	Galv. Steel	3A, 3B, 3E	4A, 4C, 4D	-2"	A	24	8B
Round general EA or RA system upstream of terminal unit	Galv. Steel	3C, 3E	4B, 4D	-2"	A	12	8B
Rectangular general EA or RA system downstream of terminal unit	Galv. Steel	3A, 3E	4A, 4C, 4D	-4"	A	6	8B
Round general EA or RA system downstream of terminal unit	Galv. Steel	3C, 3E	4B, 4D	-4"	A	3	8B
Rectangular fume EA system upstream of terminal unit	Stainless Steel	3A, 3B, 3E	4A, 4C, 4D	-2"	A	6	8B
Round concealed fume EA system upstream of terminal unit	Stainless Steel	3C, 3E	4B, 4D	-2"	A	3	8B
Round exposed fume EA system upstream of terminal unit	Stainless Steel	3E	4D	-2"	A	3	8B
Rectangular fume EA system downstream	Stainless Steel	3A, 3E	4A, 4C, 4D	-4"	A	6	8B

Duct System:	Material:	Longitudinal Joints:	Transverse Joints:	Pressure Class:	Sealant Class:	Leakage Class:	Additional Notes:
of terminal unit							
Round fume EA system downstream of terminal unit	Stainless Steel	3C, 3E	4B, 4D	-4"	A	3	8B

DUCTWORK SCHEDULE NOTES:

Longitudinal Joint Options:

3A: Pittsburgh lock. Refer to Figure 1-5, SMACNA.
3B: Button punch snap lock. Refer to Figure 1-5, SMACNA.
3C: Spiral lockseam.
3D: Snaplock.
3E: Welded.
3F: Double-wall, pre-manufactured sheet metal plenum.

Transverse Joint Options:

4A: Pre-manufactured flanged duct connection system specified under "Products" section of this specification.
4B 0-24" Major Axis Diameter: Interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening.
26" Major Axis Diameter and Up: Pre-manufactured flanged duct connection system specified under "Products" section of this specification.
4C: Any standard transverse joint as shown in Figure 1-4 of SMACNA is acceptable.
4D: Welded

Sealant Class Options:

6: Seal class is defined by the following table (refer to Table 4-1, SMACNA HVAC Air Duct Leakage Test Manual):

Seal Class:	Sealing Required:
A	All transverse joints, longitudinal seams, and ductwork penetrations. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.
B	All transverse and longitudinal seams. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.
C	Transverse joints only.

Leakage:

7: Leakage Class is defined by Figure 4-1, SMACNA HVAC Air Duct Leakage Test Manual.

Additional Comments:

8A: See Drawings for further information regarding extent of stainless steel ductwork.
8B: Field welded ductwork is to be welded with filler rod of the same material as the metal that is being welded. Field coat welded joints with protective paint to prevent damage to galvanized surfaces.

3.9 PRESSURE TESTING

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Maximum Allowable Leakage: Refer to paragraph 3.6.
4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
5. Test no less than 25% of the supply air ductwork upstream of terminal units, 25% of the return air ductwork downstream of terminal units, 25% of the exhaust air ductwork downstream of terminal units, and 50% of the fume exhaust ductwork downstream of terminal units.

3.10 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

END OF SECTION 23 31 13

SECTION 23 33 00 - DUCTWORK ACCESSORIES

1. GENERAL

1.1 SECTION INCLUDES

A. Air turning devices.

B. Duct access doors.

C. Duct test holes.

D. Flexible duct connections.

E. Fire dampers.

F. Volume control dampers.

G. Gravity backdraft dampers.

H. Remote damper operators

I. Control dampers

1.2 REFEREENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Project record documents.

1. Record actual locations of access doors, test holes etc.

D. Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

E. Regulatory requirements.

1. Products Requiring Electrical Connection: UL Listed and classified.

F. Delivery, storage, and handling.

1. See Section 23 05 00.

G. Extra materials.

1. Provide two of each size and type of fusible link for fire and combination fire/smoke dampers.

2. PRODUCTS

2.1 AIR TURNING DEVICES

A. Note that air extractors or "scoops" shall not be used under any circumstances.

B. Fabricated turning vanes: Provide turning vanes and vane runners constructed in accordance with SMACNA "HVAC Construction Standards", current edition.

C. Manufactured turning vanes: Provide turning vanes constructed of 1-1/2" wide curved blades set at 3/4" o.c., supported with bars set at 2" o.c., and set into side strips suitable for mounting in ductwork.

2.2 DUCT ACCESS DOORS

A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

1. Less Than 12 Inches Square: Secure with sash locks.
2. Up to 18 Inches Square: Provide two hinges and two sash locks.
3. Up to 24 x 48 Inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.

B. Access doors with sheet metal screw fasteners are not acceptable.

2.3 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw ca, Ventlok or approved equivalent. Provide extended neck fittings to clear insulation.

2.4 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Construct flexible connector of neoprene coated flameproof fabric crimped into duct flanges for attachment to duct and equipment.

2.5 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

B. Ceiling Dampers: Galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side, and one layer on bottom side for round flaps, with locking clip.

C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches. Configure with blades out of air stream.

D. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.6 VOLUME CONTROL DAMPERS

A. Fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

1. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.

2. Operator: Minimum 3/8 inch square shaft with nylon end bearings at each end to reduce air leakage.

B. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. End Bearings: Except in round ductwork 6 inches and smaller, provide nylon end bearings on each end. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

E. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulator shall be equivalent to Sheet Metal Connectors Model RP-3, with heavy-gauge steel regulator, wing nut locking assembly, and stamped dial indicating damper position.
2. On externally insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters to avoid damaging or compression of insulation.
3. Where rod lengths exceed 30 inches, provide regulator at both ends.

2.7 TAKEOFFS

A. Manufactured high-efficiency takeoff with 45-degree slope on the body, with gauge thickness equal to adjacent ductwork.

2.8 GRAVITY BACKDRAFT DAMPERS

A. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer’s standard construction.

B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16 gage thick extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

3. EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 13 for duct construction and pressure class.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts and stainless-steel accessories in stainless-steel ducts.

C. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. Upstream or downstream from duct silencers.
8. Control devices requiring inspection.
9. Elsewhere as indicated.

D. Unless duct access door size is explicitly indicated, provide minimum 24 x 18 inch size duct access doors wherever possible. Provide 18 x 18, 12 x 12 inch or 8 x 8 inch size elsewhere, using the largest size possible.

E. Install access doors with swing against duct static pressure.

F. Provide duct test holes where indicated and required for testing and balancing purposes. Coordinate all test hole locations with UNLBSM commissioning representatives. Install with minimum 24” clear dimension from any side wall or other obstruction.

G. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations indicated and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

H. Coordinate installation of all fire dampers, combination fire and smoke dampers, and smoke dampers with all other disciplines to ensure a minimum of 24”x24” clear horizontal access area from the ceiling vertically to the damper. The clear access area will be used for the inspection of damper fusible links and damper operators, as well as for the resetting of damper. Clear access areas and appropriate wall/ceiling access panels, if required, shall be clearly shown on the coordination drawings.

I. Provide turning vanes on all 90 Deg mitered elbows and splitter vanes on all radius elbows unless the elbow has a center line radius of 1.5 times the width of the duct (SMACNA type RE1 elbow).

J. Do not install any volume control, fire or combination fire/smoke dampers in fume exhaust ducts.

K. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.

L. All fire and combination fire/smoke dampers shall be commissioned (tested) in the presence of Owner representative following installation and before the corresponding fan systems are turned on. Contractor shall open all access doors for the inspection and close all doors in the presence of the inspector.

M. Demonstrate re-setting of fire dampers to Owner's representative.

N. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators. Install flexible connectors with adequate flexibility to allow for all thermal, axial, transverse and torsional movement. Provide airtight seal. For fans developing static pressures of 5.0 inches and over, cover connections with leaded vinyl sheet, held in place with metal straps.

O. Provide balancing dampers at points on supply, return, and exhaust systems where indicated on plans.

P. Set dampers to fully open position before testing, adjusting, and balancing.

Q. Provide a high-efficiency takeoff with 45-degree entry for each branch connection.

R. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, unless dampers are specified as part of the diffuser, grille, or register assembly. Dampers shall be fitted with quadrant control and standoff to extend through insulation. Omit manual balancing damper at single diffuser served by a single air terminal box.

S. The use of splitter dampers is not acceptable.

T. Install remote damper actuators where the volume damper is not accessible. Field paint the remote actuator cap to match the adjacent ceiling finish.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate and test fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed. All such tests shall be accomplished in the presence of a representative of BSM commissioning team.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 36 00 - AIR TERMINAL UNITS

1. GENERAL

1.1 SECTION INCLUDES

A. Variable volume terminal units.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.

C. Project record documents.

D. Operation and maintenance data.

1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

E. Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

F. Regulatory requirements.

1. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

G. Warranty.

1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

2. PRODUCTS

2.1 SINGLE DUCT VARIABLE VOLUME UNITS

A. See Drawings for further information.

B. Basic Assembly:

1. Casings: Minimum 22 galvanized steel.
2. Liner: Fiber-free internal liner.
3. Air Outlets: S slip and drive connections.

C. Basic Unit:

1. Configuration: Air volume damper assembly inside unit casing.

2. Provide protective metal shroud for UNL provided and installed control components.
3. Volume Damper: Construct of steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 4 percent of design air flow at three (3) inches inlet static pressure.
4. Mount damper operator to position damper normally open or normally closed as required by the operation sequence.
5. On units with heating coils, provide minimum 9”x6” hinged and gasketed access door on bottom of unit to facilitate coil inspection.

D. Velocity Sensors: Removable multipoint array at air inlet.

E. Hot Water Heating Coil:

1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
2. Provide factory-insulated coil bends.
3. Capacity: As scheduled.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide ceiling access doors or locate units above easily removable ceiling components. In no instance shall units be installed in inaccessible locations.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Connect to ductwork in accordance with Section 23 31 13.

E. Maintain a minimum of 18” clearance in front of VAV controller.

F. Provide a minimum of 5 straight duct diameters upstream of VAV box inlet.

G. Flexible duct connections to VAV boxes are not permitted.

H. EPDM pressure/temperature tap (“Pete’s plugs”) shall be installed on HWS/HWR piping at each terminal unit.

3.2 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.3 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation as indicated on equipment schedule.

END OF SECTION 23 36 00

SECTION 23 37 00 - AIR OUTLETS AND INLETS

1. GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

C. Louvers.

1.2 REFERENCES

A. See Section 23 05 00.

1.3 SUBMITTALS

A. See Section 23 05 00.

1.4 PROJECT RECORD DOCUMENTS

A. See Section 23 05 00.

1.5 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500. Submit AMCA certification with submittal.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

2. PRODUCTS

2.1 CEILING DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.

2.2 WALL REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide wall registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule.

2.3 LOUVERS

A. General: Except as otherwise indicated, provide manufacturer's standard units where shown; of size, shape, capacity, finishes, and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide units that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with schedules.

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.

D. Provide units with 1/2 inch square mesh for exhaust and 3/4 inch for intake birdscreens, insect screens are not allowed. Install such that screens are easily removable from an accessible location.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with adjustable elbow. Install maximum length of 5’ of flexible duct upstream of each diffuser and grille, unless otherwise noted. See details on Drawings. All connections shall be air tight.

D. In laboratories with ventilated workstations, position diffusers so that airflow is directed parallel to the front of the workstation, not perpendicular to it.

E. Where diffusers are located near fume hoods, canopy hoods, biological safety cabinets, or other devices which are sensitive to air turbulence, install diffuser to direct airflow parallel to the front face of the device (i.e. not directed at device).

F. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly. Where a balancing damper has been omitted from drawing, consult engineer.

G. Paint ductwork visible behind air outlets and inlets matte black.

H. Provide return air sound boot on grilles as shown on drawings.

I. Where slot diffusers or linear diffusers are located near perimeter windows, adjust at least one slot to direct air toward window.

END OF SECTION 23 37 00

SECTION 23 73 13 – AIR HANDLING UNITS

1. GENERAL

1.1 SECTION INCLUDES

A. Custom air handling units.

B. Drain pans.

C. Heating coils.

D. Filter sections.

E. Cooling coils.

F. Humidifiers.

1.2 RELATED SECTIONS

A. Section 23 07 13 - Ductwork Insulation.

B. Section 23 31 13 - Ductwork.

C. Section 23 33 00 - Ductwork Accessories: Flexible duct connections.

D. Section 23 05 48 – HVAC Vibration Controls

1.3 REFERENCES

A. See Section 23 05 00.

1.4 SUBMITTALS

A. See Section 23 05 00.

1. Provide literature which indicates dimensions, weights, capacities, ratings, fan performance, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Certified coil performance data. All coil performance data shall be computer generated.
3. Provide data of filter media, filter performance data, filter assembly, and filter frames.
4. Provide fan curves with specified operating point clearly plotted.
5. Submit sound power level data for all inlets, outlets, and casing radiation at rated capacity. Provide calculated sound power data based on AMCA 320 sound intensity test methods.

1.5 OPERATION AND MAINTENANCE DATA

A. See Section 23 05 00.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience, who issues complete catalog data on total product.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 23 05 00.

B. Unit shall ship with all openings securely covered with wood and / or nylon reinforced plastic wrap and to be watertight. Each unit (will be covered by a tarp) and securely strapped down on an open flatbed truck.

C. Units must be stored in a clean dry area and protected from the weather and construction traffic. Carefully follow manufacturers' storage instructions if installation does not immediately follow arrival at the job site.

D. Follow manufacturers rigging guidelines for movement and installation of equipment.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fans have been test run under observation.

1.9 EXTRA MATERIALS

A. Provide one extra full replacement set of each type of filters for each unit scheduled.

1.10 WARRANTY

A. Unit manufacturer to warrant its product to be free of defects in materials and workmanship under normal use when installed and operated in accordance with factory recommendations for a period of 18 months from date of shipment or 12 months after initial equipment start-up, which ever occurs first. Equipment found to be defective should be replaced or repaired to include all parts and labor. Component parts that require periodic replacement due to normal wear such as filters, fan belts, etc. are not covered by the warranty.

2. PRODUCTS

2.1 GENERAL DESCRIPTION

A. The Contractor shall furnish and install the indoor custom air handling unit(s) as shown and scheduled on the plans. The units shall be installed in strict accordance with the specifications. All units shall be complete with fan section(s), coil section(s) and all accessories specified.

B. Configuration: As scheduled.

C. Performance Base: 1000 ft altitude conditions.

D. Fabrication: Conform to AMCA 99 and ARI 430.

E. Manufacturer: Subject to compliance with all specified requirements, provide air handling units by one of the following manufacturers:

1. Temtrol by CES Group.
2. Huntair by CES Group.
3. Air Enterprises.
4. Climate Craft.
5. TMI Custom Air Systems.
6. Trane Custom.
7. Team Air.
8. Alliance Air

2.2 PERFORMANCE REQUIREMENTS

A. See schedule on Drawings for performance requirements.

B. Various manufacturers may be able to optimize air handling unit performance with more or less fans than scheduled, with slightly different coil fin spacing, etc. The following parameters will be used in the evaluation of custom air handling units:

1. Unit dimensions shall be less than or equal to those shown on the schedule.
2. Maximum operating brake horsepower, at the scheduled external static pressure, shall be less than or equal to the value listed in the schedule.
3. At least one redundant fan shall be provided per fan array.
4. Cooling coil capacity shall be greater than or equal to the total and sensible capacities listed in the schedule.
5. Heating coil capacity shall be greater than or equal to the total capacity listed in the schedule.
6. Humidifier capacity shall be greater than or equal to the total capacity listed in the schedule.
7. Sound levels (supply air outlet, exhaust air outlet, outside air inlet, return air inlet, and casing radiated) shall be with 2 dB or less of each of the octave band sound power levels listed on the schedule.
8. Maximum leakage shall be less than or equal to the value shown in Paragraph 2.3.F.
9. All control points shown on the Drawings shall be able to be shared with the building EMCS.
10. Manufacturer shall verify that air handling unit will operate correctly with vibration controls specified in Section 23 05 48.

C. All requirements of this specification and the Drawing equipment schedule remain in full effect, regardless of manufacturer's variations in number of fans.

2.3 CABINET

A. Casing Construction: Walls and roof to be minimum 2" double wall construction. Cabinet shall be a minimum 16-gauge A60 galvanized solid outer panel and a minimum 20-gauge G90 galvanized, perforated inner liner. Panels shall be standing seam construction with seams turned inward to provide a smooth flush exterior. Panels shall be bolted together on maximum 8" centers with minimum 5/16" zinc plated bolts sealed with a continuous bead of silicone caulking applied between the matching panel seams prior to assembly (sandwiched and sealed by the compression of the panels), and with a final bead following assembly on both the exterior and interior panel seams to produce an air tight unit. Wall to base skin and wall to roof panel seams shall be sealed with 1/2" x 1/8" Poron-Rubber strips and all exterior seams shall be continuously caulked to assure leak-proof integrity of the unit housing. AHU unit housing shall be constructed to prevent conditioned air bypass or mitigation through unit walls, roof and floor around any interior partition or component blank-off walls such as for filters, coils or fan bulkheads.

B. Insulation: Panels to be insulated with 2" - 3-pound double density pre-molded rigid board fire-resistant with matte face insulation or with spray foam insulation with similar thermal characteristics. Provide full thermal break between inner and outer walls. Insulation to meet NFPA 90A, NFPA 90B and ASTM E 84 requirements for Flame Spread of 25 or less and Smoke Development of 50 or less. Insulation shall have a thermal conductivity K factor of .23 Btu/hr/Sq. ft/degree F @ 75 F mean and provide the following sound attenuation characteristics (per ASTM C 423 - Type "A" Mounting):

1.	Octave bands	125	250	500	1k	2k	4k	8k
2.	Absorption Coefficient	.17	.80	1.16	1.15	1.11	1.10	1.05 (for 2" – 3#)

3. All cut edges of the board insulation shall be completely enclosed by the unit panels.
4. A finish bead of caulking will be applied over all foil to panel seams and/or inner liners to main panel seams to completely encapsulate the insulation.

C. Interior liners: Liners shall be minimum 20-gauge G90 exposed solid metal throughout the unit for the walls and roof except in the cooling coil section, humidifier section and its immediate

downstream plenum which will have solid 304 SS inner liners. A finish bead of caulking will be applied between the liner and the interior panel seams to completely seal the panel.

D. Roof panels: On indoor units, panels shall be flat with smooth exteriors the same as the side panels.

E. Stiffeners of angle steel shall be supplied as required to maintain a casing deflection criteria of L/240 at 8" static.

F. Unit Leakage: Entire unit shall have less than 1% air leakage at 1.5 times design static pressure or 10" w.g., whichever is greater.

2.4 ACCESS DOORS

A. Access doors shall be 2" double wall thermal break construction with A60 galvanized exterior panels and A60 galvanized interior panel. Door jamb & frame shall be constructed of extruded aluminum with continuously welded corners for rigidity. Door panels shall be insulated with 2" expandable foam insulation completely encapsulated and sealed between the door panels and frame. Provide doors located and sized to allow for routine maintenance including motor replacement and filter replacement, electrical components and any other sections or components requiring access or maintenance.

B. Doors shall be provided with a minimum (2) dual acting heavy duty key locking composite latches through 48" high, (3) latches through 72" high. Latches shall be operable from both the interior and exterior of the unit. Door latches on doors into fan sections shall be provided with a hasp or other mechanism to facilitate locking of the doors. Door hinge shall be heavy duty stainless steel. Door shall be sealed with continuous hollow closed cell foam gasket.

C. Doors to be provided with double high performance closed cell replaceable neoprene bulb type gasket seals around the entire perimeter of the door / frame.

D. Doors shall open against static pressure unless obstructed by internal components. If obstructed by internal components on the positive sections requiring access, the doors shall open with pressure and shall be provided with a safety restraining mechanism. Doors used to access rotating equipment shall be provided with an OSHA approved safety latching mechanism requiring a tool to open and shall also have a highly visible, permanently fixed, caution sign on the exterior of the door. Doors with access to moving parts must also have locking hardware and meet current UL mechanical protection guidelines. Standard door size shall be 24" wide by 60" high unless restricted by height or section width.

E. Doors shall be provided with double-pane glass viewing windows as called out for on the unit drawings in the specifications. Minimum window size to be 9" x 9" with 12" x 12" provided door size permitting.

2.5 BASES

A. Unit bases shall be constructed from structural steel channel iron around the entire perimeter of the unit and provided with intermediate structural tubing, channel and angle iron as required to support all internal components. All tubing, channel and angle joints shall be solid welded. Bolted or formed channel bases are not acceptable.

B. The unit base shall be covered with a 12-gauge tread-plate floor with continuously welded seams. Base shall be provided with removable lifting lugs minimum (4) per section, properly located to assure uniform loading. Maximum spacing between lifting lugs shall be 120".

C. Base shall be insulated with 4" insulation under the base skin and covered with a minimum 20 gauge galvanized steel liner. Insulation to meet same criteria as explained under the cabinet casing requirements.

D. Drain pans shall be 304 stainless steel double-walled construction with solid welded seams for complete water capture and containment. Pans under cooling coils shall extend a minimum 12" passed the leaving face of the coil in direction of airflow. Drain pans shall be fully recessed in the unit floor and all headers and return bends shall be located over the drain pan for collection of all condensate forming on headers and return bends. All coils shall be easily removable without cutting or removing any portion of the drain pan. Pans shall be insulated between the liner and the main pan. Pans shall be IAQ double sloping to a single drain. Drain connection shall be a minimum 1-1/4" diameter MIPS thread extending out through the channel base the same side as the coil connections unless other wised indicated on the drawings. Pans shall be provided for cooling coils, preheat coils, humidifiers, outside air intakes and under other components as required.

1. Provide one drain pan and drain pipe per coil.

E. All large openings (greater than one square foot) in the floor, including dampers openings, shall be covered with a removable powder coated heavy gauge steel grating bolted in place suitable for walking on which will prevent any personnel and large objects from falling through into the space below. Grating shall be capable of supporting minimum 300 pounds.

F. Provide a perimeter collar around the entire unit and around each floor opening to ensure unit is watertight. The entire base shall act as a secondary drain pan to hold up to 1" of water.

2.6 FINISH

A. The exterior panel finish shall be non-paint, bright spangled galvanized.

2.7 FAN ARRAY

A. The fan array system shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified, (Class I, II, or III). All fans shall be selected to deliver the specified airflow quantity at the specified operating total static pressure and specified fan/motor speed. The fan array shall be selected to operate at a system total static pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11 gauge, A60 galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 galvanized steel motor support plate and structure. All motors shall be standard pedestal mounted type, TEFC, T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. All motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

1. The fan array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10^-12 watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the air handling unit beyond the maximum length shown on the equipment schedule.

2. Manufacturers must submit acoustical data for review and approval prior to the bid indicating that the proposed alternate equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection location, unit weights, acoustical performance, or specified total fan HP for each fan array.

Proposals submitted which indicate a higher operating fan brakehorsepower than specified or scheduled will not be accepted.

B. The fan array shall consist of multiple fan and motor ”cubes”, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. The fan array shall be configured such the connected horsepower at reduced flow conditions may be less than the installed total horsepower of the fan array in order to achieve optimum system efficiency.

C. The entire fan array shall be wired to the unit exterior for factory connection to VFDs. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.

D. The fan array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12” from the intake side of the fan array intake plenum wall, and at a distance of 48” from the discharge side of the fan array intake plenum wall.

E. Each fan/motor assembly shall be removable through a 30” wide, free area, access door located on the discharge side of the fan wall array.

F. Provide equipment rail on the interior roof of each fan array discharge section to assist maintenance personnel with fan/motor replacement. Rail shall be designed to support the full weight on (1) fan/motor “cube”, using a 50% safety factor.

G. Each fan/motor “cube” will be provided with an individual back-draft damper similar to a Ruskin BD6 Heavy Duty 6063T5 extruded aluminum frame, .125” wall thickness. Frame shall have galvanized steel braces on all corners. Blades shall be minimum .070” wall thickness 6063T5 extruded aluminum. Bearings shall be corrosion resistant long life synthetic. Linkage shall be ½” tie bar with stainless steel pivot pins.

H. Each fan assembly shall be supplied with a complete flow measuring system which indicates airflow in cubic feet per minute. The flow measuring system shall consist of a flow measuring station with four static pressure taps and four total pressure tubes located at the throat of the fan inlet cone. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator, located on the unit exterior, shall provide a 4-20 ma or 0-10 volt output control signal for use in the EMCS.

I. The manufacturer shall provide (1) complete spare fan/motor assembly for emergency replacement, (1) for each fan array in each AHU provided on the project.

2.8 FAN ARRAY - ELECTRICAL

A. Provide a complete electrical and control system required to run the fan array system including all equipment, material, electrical enclosure, electrical components and electrical labor.

B. Fan array designs shall be in accordance with specific system requirements. Please see system requirements before electrical design of fan array system is to commence.

C. Fan array electrical designs shall be in accordance with the NEC, UL 508A, and local codes.

2.9 FAN ARRAY VARIABLE FREQUENCY DRIVES

A. VFDs to be provided and installed by UNL. Each fan to be controlled by separate VFD. Coordinate exact requirements with UNL.

2.10 MOTOR CIRCUIT PROTECTION

A. All motors in the fan array shall be provided with individual motor protection for thermal overload protection. All motor circuit protectors shall be located in main enclosure.

B. If required by design, all motor circuit protectors shall be mounted and located in a remote motor circuit protector panel as needed that is separate from the main enclosure. Motor circuit protector enclosure must be located and mounted at a minimal distance from motors in the fan array.

2.11 SHAFT GROUNDING

A. As required by system design, when using variable frequency drives provide an AEGIS SGR shaft grounding system for each AC motor to prevent electrical damage to motor bearings and to extend motor life by safely channeling harmful shaft currents to ground. The AEGIS SGR Conductive MicroFiber Brush system is installed by sliding a ring over the end of the motor shaft and locking it in place with screw on mounting brackets. The AGEGIS system is frictionless, has no wear and requires no maintenance or additional service during the life of the motor.

2.12 WATER COILS

A. Chilled water coils shall be of the aluminum plate ripple fin .0075 extended surface rated in accordance with ARI 410 for water, steam or ethylene/propylene glycol water mixture. The tubes shall have a minimum .035-wall thickness of seamless copper expanded into the fin collars to provide a permanent mechanical bond. Return bends shall be a minimum of one tube thickness greater than the main tubes, brazed replaceable copper. Coil headers shall be non-ferrous seamless copper, and provided with brass or copper male pipe connections. Pipe connections shall be same end connections. Each coil supply & return connection shall be raised / lowered a minimum 6” from the bottom / top of the coil to allow room for piping connection hookup especially between stacked coils, coils near floors & coils near roofs. Each coil shall be provided with capped vent & drain connections extended to the exterior of the cabinet. All coils shall be fully drainable with no trapped tubes. Coils shall be counter flow design with connections either left or right hand as specified.

B. Coil casings shall be minimum 304 stainless steel, with formed 3/4” flanges on all sides of the coil with the tube sheets having pressed or extruded tube holes. The coil casing shall be reinforced so that the maximum unsupported length is 60”. The reinforcements shall be of the same material as the casing. Both ends of the coil to be sealed off from the main air stream by full height blankoffs on both the entering air and leaving air sides. Blankoffs to be the same material as the coil casing. Headers and return bends to be further insulated with a closed cell neoprene gasket the full height & width of the coil casing to reduce condensation.

C. All coils are tested and rated in accordance with the ARI Standard 410 and certified in accordance with the ARI certification program. All tubes shall be tested at a minimum 1500 PSIG and all assemblies tested under water at 350 PSIG and rated for 250 PSIG working pressures. Individual tube and core tests before installation of header are not considered satisfactory. Hydrostatic tests alone will not be acceptable.

D. Stacked coils: Stacked coils shall be mounted in stainless steel racks to allow individual coil removal without interference to other coils. Racks to be designed to allow coil removal through the roof of the unit if required. All coils to be removable from either side of the unit by easily removable end panels. Individual end panels to be supplied for each coil on the supply & return side of the cabinet to allow single coil piping breakdown for coil removal.

E. Coil supply & return piping connections extending through the cabinet wall shall be sealed by rubber grommets with caulking on the exterior of the casing. The escutcheon plate shall have a rolled collar around the pipe opening to protect the pipe and be equipped with an “O” ring rubber gasket between the collar and the pipe to prevent chaffing and provide an air tight seal around the opening

2.13 HUMIDIFIERS

A. Humidifiers: Certify capacities and selection in accordance with ARI 610.

B. Steam Grid Humidifier: DriSteam Ultrasorb – No Equivalent. Stainless steel distribution tube with evenly spaced orifices extended full width of unit, factory mounted in location indicated on the plans and schedules. Provide blank-off panels as recommended by humidifier manufacturer.

1. Provide PVDF coating on dispersion tubes, coating to be have a 0/0 flame/smoke spread rating, and rated for 300 Deg. F operation. Coating to be Dristeem PVDF coating or equivalent.

2.14 FILTERS

A. Filters shall be arranged for face, rear or side loading as indicated on the detail drawings. Face loading is preferred where space allows. Face or rear loading to be in gasketed universal holding frames. The filter rack assemblies to blanked off to the sides, roof and floor and properly sealed to minimize filter bypass.

B. All filters to be UL approved.

C. Pre-filters and final-filters shall be provided upstream of first coil within air handling unit. Provide Type 8 filter holding frame for all filters.

D. The prefilter section shall be factory fabricated as an integral part of the air handling unit. Filters to be arranged for face (rear) loading into a gasketed universal holding frame. Prefilters shall have a minimum filtration level of MERV 8. Pre-filters shall be not less than 7 square feet to 1 square foot of face area for the 4” thick pleated filter. Final dust holding capacity shall be a minimum of 200 grams at 1.0” w.g. Pre-filters shall be Camfil Farr 30/30 – No Equivalent.

E. Intermediate and/or high efficiency filters. The filter section shall be factory fabricated as an integral part of the air-handling unit. Filters to be arranged for face or rear loading into a gasketed positive sealing universal holding frame.

F. Each filter bank to be provided with a magnehelic air filter gauge with adjustable signal flag. Gauges to be flush mounted. Exterior unit gauges to be covered with a weatherproof enclosure to protect the gauge and prevent hazing of the glass.

G. Provide walk-in filter access sections upstream / downstream of each filter rack with adequate space for filter service.

H. Filter banks to be sized so maximum filter face velocity does not exceed 450 fpm or velocity shown on equipment schedule, whichever is lower.

2.15 LIGHTS/CONTROL WIRING

A. Provide vapor proof marine type 150-watt light fixtures in each accessible section complete with a protective metal cage and sealed glass enclosure. Lights to be wired to a common switch mounted in a weatherproof box adjacent to the fan access door complete with a convenience outlet. Outlet shall have an indicator light. Power shall be 120v/1/60.

B. All wiring to lights shall be in conduit and internal to the unit. No external conduit runs for the lights are allowed.

C. Air handler manufacturer shall allow a minimum 1.5” clearance above the entire width of each interior bulk headers (coils, filters, fan blankoff, etc.). This will be to allow wiring of any 110v or 24v

runs internally to the unit as required by the controls contractor and reduce the number penetrations of the exterior panels.

D. If the unit requires splitting, junction boxes shall be furnished at each section to allow the electrical contractor to make final connections in the field. Wiring to be clearly labeled at junction points to facilitate reconnection.

2.16 CONTROL DAMPERS

A. Furnish and install as scheduled on plans. All control dampers shall be TAMCO 1500 or 9000 no equivalent.

B. Economizer (return air, relief air, outside air) control dampers are furnished by UNL BSM and installed on-site in the unit.

3. EXECUTION

3.1 INSTALLATION

A. Examine rough-in for hydronic, condensate drainage piping and electrical to verify actual locations of connections prior to installation.

B. Install central-station air-handling units level and plumb, in accordance with manufacturer's written instructions, on minimum 6” high base rail.

C. Support floor-mounted units on concrete equipment bases. Secure units to anchor bolts installed in concrete equipment base.

D. Arrange installation of units to provide maximum access space around air-handling units for service and maintenance.

E. Install a continuous neoprene vibration isolation pad below each base. See schedule for thickness and deflection requirements.

F. **The air handling units, energy recovery wheel, exhaust fans, and other HVAC airside equipment shall not be used for temporary building conditioning without the written permission from the UNL FMP.**

1. If unit is approved for operation prior to substantial completion, contractor is fully responsible for all preventative maintenance. Preventative maintenance to be completed per all manufacturer recommendations. In addition, contractor is fully responsible for all cleaning of the systems to the satisfaction of the UNL FMP.

G. Air handlers shall not be operated without filters. Temporary filters of specified type shall be installed prior to unit start-up. These shall be changed as required by static pressure drop readings during construction and once again (regardless of static pressure drop readings), before acceptance by UNL

H. Pipe drain pans to floor drain. Provide trap and water seal having a depth of 1.5x the operating static pressure of the system at the drain pan location.

3.2 EQUIPMENT BASES

A. See Section 23 05 00.

3.3 COMMISSIONING

A. Perform the following operations and checks before start-up:

1. Adjust damper linkages for proper damper operation.
2. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.
3. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
4. Comb coil fins for parallel orientation.
5. Install clean filters. Install clean filters again at time of substantial completion.
6. Measure and record motor electrical values for voltage and amperage.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

END OF SECTION 23 73 13

SECTION 23 82 39 - TERMINAL HEAT TRANSFER UNITS

1. GENERAL

1.1 SECTION INCLUDES

A. Panel radiators.

1.2 REFERENCES AND REGULATORY REQUIREMENTS

A. See Section 23 05 00.

1.3 SUBMITTALS

A. See Section 23 05 00.

1.4 OPERATION AND MAINTENANCE DATA

A. See Section 23 05 00.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.

1.6 DELIVERY, STORAGE AND HANDLING

A. See Section 23 05 00.

1.7 SEQUENCING AND SCHEDULING

A. See Section 23 05 00.

B. Install cabinet unit heaters only after walls and ceiling are finished and painted.

2. PRODUCTS

2.1 PANEL RADIATORS

A. General: Provide panel radiators of lengths and in locations indicated on the plans. Provide units of capacities, styles, features and accessories as scheduled.

B. Panels: Panels shall be manufactured of cold rolled low carbon steel, fully welded and consisting of header pipes at each end, connected by flat oval water panels. Tube thickness shall be suitable for a working pressure of 128 psig. Header pipes shall be square tube with air vent connection, ¾ “inlet and outlet connection and internal baffles as required.

C. Finish: Factory applied baked enamel finish on covers and accessories. Color is to be selected from the manufacturer extended color chart.

D. Accessories as required by installed location: Provide all necessary end panels, outside and inside corner panels, and enclosure extensions to completely conceal all supply and return piping.

E. Provide 5-year limited warranty.

3. EXECUTION

SECTION 23 82 39 - TERMINAL HEAT TRANSFER UNITS

3.1 EXAMINATION

A. Verify that required utilities are available, in proper location, and ready for use.

B. Beginning of installation means installer accepts existing surfaces.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Hang unit heaters from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

C. Install cabinet unit heaters and fan coil units as indicated. Coordinate to assure correct recess size for recessed units.

D. Locate panel radiators as indicated on plans. Install elements as indicated on plans. Install accessories as noted on the plans. Provide backing inside the wall cavity or floor stands as recommended by the manufacturer. Coordinate exact mounting height and locations with architectural drawings.

E. Protect units with protective covers during balance of construction.

F. Provide hydronic units with valving as detailed on the plans.

EPDM pressure/temperature tap (“Pete’s plugs”) shall be installed on hydronic supply/return piping at each unit.

3.3 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Comb all bent fins on coils.

END OF SECTION 23 82 39

SECTION 26 00 00 - BASIC ELECTRICAL REQUIREMENTS

NOTE: THIS IS A SHORT FORM MASTER SPECIFICATION. IT SHALL BE USED FOR ALL APPLICABLE PROJECTS. IT IS THE RESPONSABILITY OF THE A/E VENDOR/SPECIFIER TO ADD, DELETE OR REVISE AS NECESSARY TO ADDRESS ACTUAL PROJECT REQUIREMENTS.

1. GENERAL

1.1 RELATED DOCUMENTS

A. The General Conditions and Supplementary Conditions are applicable to all contracts for the project.

1.2 DESCRIPTION OF WORK

A. The work included under this Section consists of providing all work, supervision, and construction procedures necessary for the installation of the complete electrical systems required by these specifications and/or shown on the drawings of the contract.

B. Install and connect all appliances and equipment as specified and indicated for this project, in accordance with the manufacturer's instructions and recommendations. Furnish and install complete electric connections and devices as recommended by the manufacturer or required for proper operation.

1.3 ACCESS TO EQUIPMENT

A. Starters, switches, receptacles, pull boxes, etc., shall be located to provide for easy access for operations, repair and maintenance; if concealed, access doors shall be provided.

2. SHOP DRAWINGS

2.1 The Contractor shall furnish shop drawing portfolios and proper transmittal forms for all materials, equipment, and lighting fixtures to be incorporated in the work, in accordance with the General Conditions, Supplementary Conditions, and all other applicable Conditions.

2.2 Shop drawings on component items forming a system or that are interrelated shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function properly as a system. A notation shall be made on each shop drawing submitted as to the items specific use, either by a particular type number referenced on the drawings or in the specifications, or by a reference to the applicable paragraph of the specifications or by a description of its specific location. The shop drawings shall be organized and bound into sets with each set collated.

2.3 The Architect/Engineer shall have the final authority as to whether the fixture is equal to the specified item. The proposed substitution may also be rejected for the aesthetic value if felt necessary or desirable. In the event the proposed substitutions described are rejected, the Contractor shall furnish the specified item.

3. CODES AND STANDARDS

3.1 The electrical work shall be in accordance with all applicable state and local codes, building ordinances and the N.E.C. The electrical work shall merit the approval of the state and local enforcing authorities.

4. PERMITS AND FEES

4.1 The Contractor shall pay for all permits and/or fees required for the work.

5. MATERIALS AND WORKMANSHIP

5.1 All materials shall be new and of the quality specified. Materials shall be standard products of manufacturer's regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design. Electrical material and equipment used in the work shall meet the requirements as specified under paragraph three of this section, CODES AND STANDARDS.

5.2 All work installed under this Division of the Specifications shall be first class and complete in both effectiveness and appearance, whether finally concealed or exposed, and shall be executed by experienced mechanics.

6. INSTALLATION METHODS

6.1 Conductors shall be installed in concealed raceways except as shown or specified on the Contract Documents. Exposed conduits and wires shall be installed parallel or perpendicular to all building surfaces. Conduits and wires in the space above ceilings shall be supported adequately and not laid on the top of ceiling systems. All conduits and wires installed above ceilings shall be considered exposed.

6.2 Electrical conduits shall not be hung on hangers with any other service foreign to the electrical systems, nor shall they be attached to other foreign services.

6.3 The lighting and power branch circuit conductors shall be installed in separate raceway systems unless specifically shown or noted otherwise.

6.4 Equipment Bases. Provide concrete equipment bases for all floor mounted equipment furnished under the contract. Concrete bases shall be 3-1/2" high unless noted otherwise and shall extend 3-inches on all sides of the unit. Trowel all edges at a 45 degree angle. This work shall be done under Division 3 of the specifications. Bases shall be provided for switchboards, motor control centers, transformers and all other floor mounted equipment.

6.5 Outlet Box Locations. Outlet boxes shall be located so they are not placed back-to-back in the same wall in order to limit sound transmission from room to room.

6.6 PROTECTION FROM WEATHER

A. Raceway stub ups shall be capped or otherwise protected from moisture and debris until such time that the conductors are pulled. Conductors shall not be installed in raceways until the building is protected from the weather, all concrete and plastering is completed and raceways in which moisture has collected have been swabbed or blown out.

6.7 ELECTRICAL ROOM COORDINATION

A. Where a number of electrical panels and/or related electrical items are shown, the Electrical Contractor shall coordinate the physical sizes with his equipment suppliers to ensure that there is adequate space for the items shown to be installed in those areas and that all Code required clearances are maintained.

B. The Contractor shall rearrange the equipment layout to achieve full use of the available space prior to installing conduit stub ups. Where a conflict or rearrangement exists, the Contractor shall submit a proposed revised layout of the area to the Architect.

6.8 LIGHTING SYSTEM SWITCHING

A. The lighting design for this project has included multi-level lighting in some areas. Where 3 lamp fixtures are shown in a room, the outer 2 lamps will be switched from one switch and the center lamp will be switched from the other switch by means of dual ballasts. Where 4 lamp fixtures are shown in a room, the outer 2 lamps will be switched from one switch and the center 2 lamps will be switched from the other switch by means of dual ballasts. The intent is to provide manual 50% lumen output reduction through switching means as an energy saving measure. When available and cost effective, provide step dimming ballast in lieu of dual ballast to provide the specified lumen reduction requirements. When available and cost effective, provide full dimming ballast and/or drivers where dimmer switches are shown. A similar multi-level lighting arrangement will be provided where 4-3 way switches are shown.

6.9 WIRING - NUMBER OF WIRES REQUIRED

A. The number of wires for lighting and receptacle branch circuits is not shown on the drawings. The number of wires in any circuit shall be determined in accordance with the National Electrical Code, and wiring shall be provided to perform all functions of the devices being installed. Additionally, wires shall be provided as required by the contract documents, i.e. equipment grounds, etc. Provide the number of wires required for a complete and workable system.

6.10 PAINTING, FINISHING

A. Painting of electrical work exposed in occupied spaces, except mechanical and electrical machine rooms and maintenance/service spaces; and work exposed on the exterior is specified and performed under other divisions of these specifications.

B. Factory finishes, shop priming, and special protective coatings are specified in the individual equipment specification sections.

C. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.

6.11 SLEEVES

A. Sleeves shall be used to accommodate conduit or tubing where conduit or tubing passes through concrete slabs.

B. All sleeves through floors shall be black iron pipe, flush with walls or finished floors; and of sizes to accommodate the raceways shown. Sleeves through outside walls above grade shall be caulked with approved caulking compound. Sleeves shall not be required through on grade slabs. Sleeves through floors shall extend above floor to an elevation that would prevent flooding of lower floors.

C. Install manufactured floor and thruwall seals, similar to Type "FSK" as manufactured by O.Z. Electric Manufacturing Company.

6.12 CABLE AND CONDUIT SEALS

A. Seals shall be provided around conduits and cables which penetrate smoke walls, fire walls, and floors. Nelson Flameseal or approved equal system shall be used to seal penetrations of electrical cables and conduits.

B. Materials used shall be as follows:

1. Flameseal putty.
2. Ceramic fiber insulation.
3. Ceramic fiber board shall be required to provide rigid support on large oversized openings. Board shall be rigid and able to withstand temperatures in excess of 2000 degrees F.
4. Accessory hardware shall be required on oversized openings.

C. Follow manufacturer's instructions in selecting the type of seals and accessories. Also follow the manufacturers instructions on installation of the cable and conduit seals.

D. Equal quality equipment by OZ Gedney and 3M shall be acceptable.

6.13 ACCESS PANELS

A. Furnish and install panels for access to junction boxes and similar items where no other means of access, such as a readily removable, sectional ceiling is shown or specified.

B. Panels shall not be less than 12-inches by 16-inches in size. Larger panels shall be furnished where required. Panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Access panels shall be flush type and of all steel construction, with No. 16 gauge wall or ceiling frame for masonry or plaster and a No. 14 gauge panel door. Doors shall be secured with concealed hinges and flush locks of either the cylinder type or approved, positive acting, screwdriver operated type. Doors for wall panels may be secured with suitable clips and countersunk screws. Panels shall be painted with a rust-inhibitive primer at the factory. Access panels in rated walls or ceilings shall be provided with rating of the same type.

7. WORK IN EXISTING BUILDING

7.1 Where drawings indicate work to be done in the existing building, the Contractor shall carefully examine such areas to determine the nature and extent of work involved before submitting his bid. The Contractor shall be responsible for all damage to existing items and utilities due to the progress of his work, and shall repair all such items or replace same to an approved condition at his own expense.

8. REMOVAL WORK

8.1 All existing devices shown with cross-hatching and/or so noted shall be removed, relocated, remain or shall be abandoned as noted on the drawings.

A. Devices shall be completely removed from walls that are also shown to be removed. Devices shown to be removed on drywall or plaster type walls that are to remain shall have the wall surface patched to match the existing. Flush type devices shown to be removed on concrete or brick type walls that are to remain shall have the device removed and shall be provided with a blank cover plate.

B. Conduits shall be completely removed from walls that are also shown to be removed. Conduits may be abandoned in walls that are to remain. All conduits and boxes that are surface mounted and no longer require active circuits shall be removed.

C. The conductors for the devices shown to be removed shall be disconnected and removed back to the panel or back to the next device shown to remain as required by the actual existing circuiting. Continuity of circuiting shall be maintained for the existing devices shown to remain. Circuiting shall be extended from new or existing circuits as shown or as required.

D. See the Architectural Drawings for wall removal and types.

9. EXISTING MATERIAL

9.1 Refer to the Supplementary Conditions Section of this specification for the disposition of all salvageable material.

10. ELECTRICAL-MECHANICAL EXTENT OF WORK

10.1 The responsibility of work specified under Division 23 and 26 is clarified under Section 23 05 13, Electrical Requirements for Mechanical Equipment. Division 23 Contractor is to coordinate all electrical requirements prior to ordering powered mechanical equipment. Said Section 23 05 13 is incorporated herein by reference.

11. CUTTING AND PATCHING

11.1 The Contractor shall be responsible for all cutting and patching of holes in the building which are required for the electrical work. Cutting, patching and painting shall conform to the requirements of the General Conditions of this specification.

11.2 Cutting of structural framing, walls, floors, decks and other members intended to withstand stress is not permitted.

11.3 All patching shall be finished and painted to match existing.

12. COORDINATION

12.1 Coordinate the locations and purchasing of equipment between other trades to ensure proper interfacement and placement of equipment requiring electrical power.

12.2 Coordinate other work of the different trades so that:

A. Interference's between mechanical, electrical, architectural, and structural work, including existing services, is avoided.

B. Within the limits indicated on the drawings, the maximum practicable space for operation, repair, removal and testing of electrical, and other equipment will be provided.

C. Pipe, conduits, ducts, and similar items, shall be kept as close as possible to ceilings, walls, columns, to take up a minimum amount of space. Pipes, conduits, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

13. ELECTRICAL SERVICE

13.1 The Contractor shall provide all material and pay all fees required by the local utility company for the connection of the new electrical service as shown on the plans. The Contractor shall also meet all equipment requirements of the local utility company. The Contractor shall provide all necessary materials for construction of the temporary electrical service and shall coordinate all details with the local utility company.

13.2 METERING

A. Contractor shall furnish all material and labor as required by the local utility company.

13.3 EXISTING UTILITIES

A. Existing utilities within the contract limits shall be rerouted and/or abandoned as shown on the drawings. The Contractor shall verify the location of all existing utilities with the Owner and Utility Companies prior to commencing excavation work. All new or rerouted work must be in place before removal of existing work. All service outages must be scheduled with the Owner and be approved by the Owner. The drawings and survey data of the contract documents indicate the available information on the existing power and communication services, and on new services to be provided to the project by local utility companies. Accuracy of this information is not assured.

14. EXCAVATION AND BACKFILLING

14.1 Contractor shall perform all excavation and backfilling necessary to install the required electrical work. Coordinate the work with other excavating and backfilling and other work in the same area. Except as indicated otherwise, comply with the applicable sections in these Specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.

14.2 Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Contractor.

15. OUTLET BOXES, PULL BOXES AND CONDUIT FITTINGS

15.1 Furnish and install outlet boxes, pull boxes, and conduit fittings as described below. Catalog numbers shown are Appleton Electric Company. Equal materials by Steel City, O.Z., and Raco, are acceptable.

15.2 OUTLET BOXES

A.	Lighting Boxes (concealed)	-	No. 40-3/4
B.	Lighting Boxes (concrete)	-	OCR Series
C.	Lighting Boxes (exposed)	-	4S-3/4 or 40-3/4
D.	Flush Switches, Receptacles Telephone and Flush Junction Boxes be used. (Provide Extension Ring or	-	No. 4S-3/4 (with box covers or No. 225) where extension or plaster ring cannot Plaster Ring as required)
E.	Weatherproof type Switch, Receptacle and Telephone Boxes (exposed)	-	FS Series w/FS cover and neoprene gasket.
F.	Switch, Receptacle and Telephone- Boxes (exposed)		4S-3/4 with 8360 or 8370 Series raised surface cover.

15.3 Where space is limited, No. 4CS-3/4 handy boxes may be used for switch, receptacle and telephone outlets with specific approval only.

15.4 Extension and plaster rings shall be installed as required by the NEC.

15.5 Outlet boxes shall comply with the National Electrical Code in regard to the allowable fill.

15.6 PULL BOXES

A. Pull boxes shall be fabricated of code gauge galvanized sheet metal and shall be sized in accordance with National Electrical Code requirements, or as shown on the drawings. Provide removable cover on the largest access side of the box. In-line conduit pull boxes may be O.Z., Type PBW, or equal.

16. RACEWAYS AND FITTINGS

16.1 Steel Conduit. Rigid steel conduit, intermediate conduit and electric metallic tubing shall be hot dipped, galvanized as manufactured by Youngston Sheet and Tube Company, National Electric or equal.

16.2 Rigid heavy wall (Schedule 40) PVC conduit may be used only for direct burial in earth and embedding in concrete. PVC conduit shall be installed as recommended by manufacturer.

16.3 Raceways shall be installed concealed. Wiremold shall be used only after Owner's approval. Wiremold shall be painted to match walls, or in accordance with the Architects' direction.

16.4 Joints. All threaded joints shall be made up wrench-tight and rain-tight. Compression joints shall be made up mechanically secure and snug so as to take continuous current-carrying electrical contacts.

16.5 Provide marking of conduit and junction boxes to indicate which distribution system they are serving. Concealed junction boxes shall be legibly marked with a magic marker to indicate the panel and circuit number that junction box serves.

16.6 Minimum conduit size to be 3/4”

16.7 All connectors and couplings shall be steel, compression or set screw type is acceptable, wet locations to be compression.

17. CONDUCTORS

17.1 All conductors shall be 600 volt and shall be copper with THW or THHN insulation. No wire branch circuit shall be smaller than No. 12.

17.2 All wires shall be installed in conduit.

17.3 Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes. Junction boxes may be used where required.

18. GROUNDING

18.1 Green ground conductor shall be installed in each conduit.

18.2 Grounding and bonding of electrical circuit and equipment shall be accomplished as set forth in the NEC.

18.3 Ground HVAC ductwork and equipment to the C.O. equipment ground. (Not C.O. ground window). Use No. 6 insulated conductor.

19. POWER PANELS

19.1 Power panels shall be Square D I-Line circuit breaker type panels as indicated on the drawings or engineer approved equal. Panelboards shall have distributed phase copper bussing throughout. Circuit breakers shall be as specified for lighting panels unless indicated otherwise. Lighting and Power panels shall have combination card holder and nameplate and shall be equipped with typewritten directories that identify all loads served and all spare circuits. Provide a copper ground bus in all power panels. Power panels shall be Underwriters Laboratory approved and shall bear the UL label. The size of the panelboard main protective device or main lugs, the size, type and the number of branch circuits and the type of mounting shall be as shown on the drawings.

20. LIGHTING PANELS

20.1 Lighting panelboards shall be Westinghouse Pow-R-Line C Type for 277/480 volt or 120/208 volt panels. Provide Square D type NF or NQOB type panels in accordance with requirements listed on the Drawings. All branch circuit breakers are to be quick-make, quick-break, trip indicating and common trip on all multipole breakers, and shall be bolt-on type. Trip indication shall be clearly shown by breaker handle taking position between "ON" and "OFF" positions. Panelboards shall have distributed phase copper bussing throughout. Lighting panels shall have combination card holder and nameplate and shall be equipped with typewritten directories that identify all loads served and all spare circuits. All panels shall be provided with a copper ground bus and shall be Underwriters' Laboratory approved and shall bear the UL label. The size of the panelboard main protective device or main lugs, the size, type and the number of branch circuits and the type of mounting shall be as shown on the drawings.

21. SAFETY SWITCHES

21.1 Furnish and install heavy duty type safety switches having the electrical characteristics, ratings and modifications shown on the drawings. All switches shall have:

A. NEMA 1 general purpose (indoor) enclosures unless otherwise noted;

B. Handle that is padlockable in "OFF" position;

C. Non-teasible, positive quick-make, quick-break mechanism;

D. UL approved and shall bear the UL label;

E. All fusible switches shall have Class R fuse rejection clips.

22. MOTOR STARTERS

22.1 Provide magnetic starters or VFD’s for three phase motors. Motor starters for equipment rated less than 50 H.P. shall be full voltage non-reversing across the line magnetic type rated in accordance with NEMA standard sizes and horsepower ratings. Minimum size magnetic starter shall not be less than NEMA size one.

22.2 Motors for equipment rated with 50 H.P. or larger shall be operated by reduced voltage starters or VFD’s. Reduced voltage starters shall be of the star delta type with closed transition.

22.3 Motor starters shall be furnished with the following options:

A. Hand-Off-Auto selector switch unless otherwise noted. An On-Off selector switch or push button station shall be provided where required.

B. Contacts: 2 normally open. 2 normally closed.

C. Control transformer; primary and secondary fuses.

D. Red running light with push to test.

E. On delay relay; adjustable 0-30 seconds.

23. LOCK-OUT PUSH BUTTONS

23.1 Lock-out push buttons where shown on the drawings, or wherever required, for remote lock-out of motors shall be Westinghouse Catalog No. 1033-321 (surface mounted) 1033-410 (flush mounted) push button with enclosure and Catalog No. 1032907 padlock type rotary latch or approved equal. At the Contractor's option where, lock-out push buttons are shown, the contractor may provide non-fusible disconnect switches for the motor circuit if space is adequate.

24. MANUFACTURERS

24.1 Panelboards, safety switches, motor controllers, and lock-out pushbuttons manufactured by Westinghouse, Square D, ITE, Gould, or General Electric are acceptable. All major components shall be of the same manufacturer.

25. FUSES

25.1 Fuses shall be furnished and installed in each fused switch, and shall have ratings as shown on the drawings.

25.2 All cartridge fuses shall be dual element Bussman Fusetron Class R Type unless otherwise noted. Three spare fuses shall be furnished for each size used. Each fused switch shall be provided with a mastic backed label clearly identifying the type and size of fuse required. Bussman HICAP Class R fuses shall be provided for fuses larger than 600 amps.

26. LIGHT FIXTURES

26.1 Furnish and install all light fixtures as shown on the drawings.

26.2 All lighting fixtures and their electrical components shall bear the UL label.

26.3 FLUORESCENT BALLASTS

A. Ballasts for fluorescent lamps shall be of the high frequency electronic type, operating lamps at a frequency of 20 KHZ or higher with no detectable flicker. All ballasts shall be UL listed and CSA certified. Ballasts shall be designed to operate (T8) or (T12) fluorescent lamps, and shall have a sound rating of "A". Ballasts shall be manufactured in the United States. Ballasts shall be manufactured by Magnetek or Advance.

B. Ballasts shall consistently start and operate lamps from a supply line voltage of plus or minus (±) 10 percent of the design voltage (120 or 277 volts). Ballasts shall provide installed light levels equivalent to C.B.M. certified electromagnetic ballasts. Light output shall not vary by more than 12 percent over a plus or minus (±) 10 percent variation in supply voltage. Ballasts shall be capable of operating remaining lamps if one or more companion lamps fail or are removed. Ballasts shall have a sequenced start progression which first heats the cathode filaments, and then ignites the lamps.

C. Ballasts shall have an input current total harmonic distortion content of less than 15 percent (based on the full light output current level). The lamp current crest factor for any ballast shall not exceed 1.6. Ballasts shall have a power factor of 95 percent or greater, and shall contain no PCB's.

D. Ballasts shall comply with all applicable State, Federal and industry performance and safety standards. Ballasts shall comply with FCC requirements governing electromagnetic and radio frequency interference. Ballasts shall comply with IEEE standards for line voltage transient protection, and shall meet or exceed ANSI and IEEE standards for harmonic distortion. Ballasts shall carry a five (5) year warranty, minimum, including all parts and labor.

26.4 Fluorescent lamps shall be T8 type.

26.5 Outdoor lighting fixtures shall be LED, or Metal Halide Type, unless otherwise shown or noted.

26.6 Ballasts for high intensity discharge lamps shall be single lamp, protected type, high power factor, CWA type ballasts unless indicated otherwise. Ballasts shall be suitable for 150 degrees F for interior applications and -20 degrees F for exterior applications. Ballasts shall be manufactured by Advance, General Electric, Jefferson, Universal, or equal. Metal halide fixtures shall be so designed as to provide complete protection as recommended by Sylvania Lamp Company.

26.7 Standard plaster frames shall be provided for all recessed lighting fixtures installed in plaster or drywall finished walls or ceilings. Coordinate with architectural drawings.

26.8 All recessed fluorescent fixture lenses shall be prismatic panel clear acrylic KSH-12 for 2' x 4' fixtures; minimum 1/8" thick.

26.9 All recessed incandescent and H.I.D. light fixtures shall be provided with thermal protection per N.E.C.

26.10 Undercabinet and undercounter light fixtures shall be installed with 3/8" deep x 2" x 4" wood spacers painted black to provide an air space between fixture and top of millwork.

27. WIRING DEVICES

27.1 All wiring devices shall be suitable for intended purpose and shall be UL listed.

A. All outlets shall be located as shown on the drawings except that where practicable, outlets shall be located in center of panels or trim or otherwise symmetrically located to conform with existing structural layout. Outlets incorrectly installed shall be corrected. Damaged items or damaged finishes shall be repaired or replaced at no expense to the Owner.

B. Outlets shall be set plumb or horizontal and shall extend to the finished surface of the walls, ceiling or floor, as the case may be, without projecting beyond same.

C. Receptacles, switches, etc., shown on wood trim, cases or other fixtures shall be installed symmetrically; and, where necessary, shall be set with the long dimensions of the plate horizontal, or ganged in tandem.

D. Where dimmer switches are shown adjacent to standard switches, both shall be installed in separate back boxes with adequate space between so that neither coverplate requires cutting.

E. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that coverplates do not require cutting.

F. Where shown on the drawings, furnish and install wiring devices indicted by the symbols. Wiring devices shall be products of Pass & Seymour, or equal. Catalog numbers shown below are Pass & Seymour hard use specification grade. Equal devices manufactured by Hubbell, Leviton, or General Electric shall be acceptable.

NOTE TO SPECIFIER: SWITCHES ARE SPECIFICATION GRADE, TUMBLER TYPE-CHANGE COLOR AS DESIRED. FOR ROCKER TYPE SWITCHES USE 26021, 26022, 26023, AND 26024.

G. Switches. Branch circuit switches shall be flush tumbler (rocker) type as follows:

Single Pole	20AC1 Series - Gray
Two Pole	20AC2 Series - Gray
Three-Way	20AC3 Series - Gray
Four-Way	20AC4 Series - Gray
Single Pole SW With Pilot	20-AC1-RPL Series - Gray

1. Switches for emergency systems shall be as shown above, but red in color.

H. Dimmer Switches: Provide dimmer switches according to the following (all catalog numbers are Lutron Nova T series, unless otherwise noted). At minimum, all dimmer switches shall be rated to accommodate the load shown to be switched on the Drawings.

Incandescent Dimmers	Catalog No.
120 Volt, 600 Watt, Single Pole	NT-600
120 Volt, 1000 Watt, Single Pole	NT-1000
120 Volt, 1500 Watt, Single Pole	NT-1500
120 Volt, 2000 Watt, Single Pole	NT-2000
Incandescent Low Voltage Dimmers (for transformer supplied low voltage lamps)	
120 Volt, 600 VA (500W), Single Pole	NTLV-600
120 Volt, 1000 VA (800W), Single Pole	NTLV-1000
120 Volt, 1500 VA (1200W), Single Pole	NTLV-1500
Fluorescent Dimmers (for 30 & 40W rapid start lamps with magnetic dimming type ballasts)	
120 Volt, 1 to 10 Lamps, Single Pole	NF-10
120 Volt, 6 to 20 Lamps, Single Pole	NF-20
120 Volt, 14 to 30 Lamps, Single Pole	NF-30
277 Volt, 1 to 12 Lamps, Single Pole	NF-10-277
277 Volt, 6 to 24 Lamps, Single Pole	NF-20-277

NOTE TO SPECIFIER: RECEPTACLES ARE RECTANGULAR TYPE FOR FIGURE 8 TYPE USE 5252. CHANGE COLOR AS DESIRED.

I. Receptacles. All receptacles shall be side and back wired, self-grounding of the type indicated as follows:

Duplex Convenience Receptacles 20A-125V (Grounding Type)	26352 Series - Gray
Weatherproof Duplex Receptacles 15A-125V (Grounding Type)	26352 Series - Gray with Weatherproof F.S. Plate
Weatherproof Duplex GFI Receptacle 20A-125 Volt	2091-F with 4511 (horizontal) or 4512 (vertical) weatherproof wall plate

Clock Hanger Outlet	2123 Gray
Hospital Grade Receptacle 20A-125 Volt (Grounding Type)	26362 Gray for Normal Power and 26362HG Red for Emergency Power
Safety Receptacle (15A) Emergency Duplex Receptacle 20A-125V (Grounding Type)	Hubbell SG-62H 26362 Red

J. Hospital grade receptacles shall be installed in all anesthetizing locations including all operating rooms, delivery, cysto, fracture, special procedure rooms and ICU and CCU rooms. Receptacles on emergency power shall be red in color. Cover plates for emergency outlets in these areas shall be engraved with panel and circuit no. designation per NEC. Engraving shall be 1/8" high, block style letters, with red filler on front side of cover plates.

K. Plates. Furnish and install wall plates for all wiring devices. Plates for flush devices shall be Sierra Smooth 430S/S line satin finished stainless steel (**or** Pass and Seymour "RP" Series high impact thermoplastic, and shall be gray in color). Oversize plates are not acceptable. Weatherproof switch plates shall be Crouse-Hinds DS185 type. Where switches and/or receptacles are shown adjacent to each other, provide a common cover plate for each group of devices.

28. MOUNTING HEIGHTS

28.1 Mounting heights to center of box and above finished floor for the below-named items shall be as follows, unless otherwise shown. All other device mounting heights shall be as shown on the drawings.

A.	Flush tumbler switches	48"
B.	Switches in concrete block	46"
C.	Switches over wainscot	6" above 48" wainscot
D.	Convenience outlets	18" mounted vertically with ground prong slot at bottom
E.	Safety switches	48"
F.	Motor controllers	48"
G.	Panelboards to top	72"
H.	TeleComm/Data outlets	18"
I.	Alarms, Annunciator Controls (Centerline)	48"
J.	Key Pad, Push Pad, Prox/Reader	48"
K.	Bracket lights (120 volt)	84"
L.	Bracket lights (277 volt)	96"
M.	Exit Sign, Em. battery Light - Wall	87"

N.	Occupancy Sensor-Switch Type	48”
O.	Occupancy Sensor Wall Directional	10’-0”
P.	Occupancy Sensor – 360 Degree	Ceiling
Q.	Clock outlets 8' ceiling 9' ceiling	90" 96"
R.	Receptacles above counters	6" above counters mounted (horizontally)-(vertically)
S.	Convenience outlets in mechanical, electrical, janitor, and elevator machine rooms	48"
T.	TeleComm/Data panels	72" to top
U.	Control Panel-FA, Gen. Intrcm.	48”
V.	Exterior W.P. convenience outlets	24" above grade mounted (horizontally)-(vertically)
W.	Capacitors furnished by Mechanical	36" minimum
X.	Lock-out push button	36" minimum
Y.	Intercom push button, Volume Control	48”
Z.	Speakers, PA, Sound System	90” or ceiling mounted
AA.	Fire alarm pull station	48"
BB.	Fire alarm horn, bell, chime or light	80" or ceiling mounted

28.2 Contractor shall check all equipment layouts and verify exact mounting heights.

29. TELEPHONE SERVICE

29.1 Refer to TeleComm/Data Sections

29.2 Local telephone company shall pull all the wires. Contractor to provide pull wires in all empty conduits.

30. EMERGENCY POWER

30.1 Connect to and utilize generators whenever available and when project budget allows.

30.2 Battery operated light fixtures shall be installed in the Corridor area. Exit lights shall be battery operated to meet the code.

31. NAMEPLATES

31.1 Nameplates shall be provided for all items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards and motor control centers, control devices and other significant equipment.

A. Nameplates shall be 1" x 2-1/2" laminated black phenolic resin with a white core with engraved lettering, a minimum of 3/16-inch high. Manufacturers factory installed nameplates shall be acceptable provided all information is furnished.

B. Nameplates shall identify the equipment item that the device is serving and also from where the device is being fed from.

32. PROTECTION

32.1 Protection of existing equipment and facilities shall be provided and coordinated with the Owner.

33. OUTAGES

33.1 All outages shall be scheduled and approved by the Owner, 72 hour minimum, refer to front end specifications for additional information. Contractor shall submit in writing a document indicating the times of day and duration of all electrical outages.

NOTE TO SPECIFIER: EDIT FIRE ALARM SYSTEM TO SUIT REQUIREMENTS.

34. FIRE ALARM

34.1 Provide a fire alarm control panel for the facility in accordance with items shown on the Drawings. Panel shall be an expandable four zone, Class B system. Fire Alarm shall have a combination annunciator/control panel with a 1-1/2 hour nickel cadmium battery backup.

34.2 All necessary equipment for a complete and workable system shall be provided, including battery charger, supervised trouble, alarm, zone indicators, reset switch and four normally open and two normally closed auxiliary contacts. (3 open for fire alarm, 1 open for fire alarm trouble; open contacts for connection to building automation system.) Provide all wiring in conduit, 1/2" minimum.

34.3 Operation shall include automatic shutdown of air-handlers and closing of smoke dampers. Existing operations at existing areas shall remain.

34.4 Additional Devices:

A. Combination horn/visual devices

B. Manual pull stations

C. Photoelectric detectors

D. Photoelectric duct detectors in air handler duct. Furnished and wired by electrical, installed by mechanical. Provide with remote reset and indicators near mechanical room door.

E. Provide wiring and accessories for closing smoke dampers furnished and installed by mechanical.

35. ASBESTOS

35.1 If asbestos is encountered or suspected during the course of work, stop all work and notify the UNL Project Manager immediately.

36. AS-BUILT DRAWINGS

36.1 Contractor shall provide the Owner as-built drawings for all systems including electrical and special systems described in specifications. This shall consist of all drawings, wiring schematics, and diagrams for the fire alarm, telephone and data systems, as well as, any change to the systems shown on the drawings.

END OF SECTION 260000

SECTION 26 05 00 – ELECTRICAL GENERAL PROVISIONS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1-specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. The work included under this Section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete electrical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, conduit, and outlets. Follow the drawings in laying out the work and verify spaces for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

1.3 QUALITY ASSURANCE

A. Installers shall have at least 2 years of successful installation experience on projects with electrical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation.

1.4 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to all codes, standards and regulations, etc. found in the front end of specifications:

B. The latest adopted edition by the local and state inspection authorities of all standards and specifications listed in front end shall apply.

C. Furthermore, the electrical work shall be in accordance with all applicable National and State Standards, and Local Codes and Building Ordinances. The electrical work shall merit the approval of the enforcing authorities having jurisdiction.

1.5 MATERIALS AND EQUIPMENT

A. Electrical materials and equipment for the entire project shall meet the requirements specified under the Supplementary Conditions Section of this specification.

B. Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable Codes whether or not each piece of conductor, conduit, or protective device is shown between such items of equipment or fixtures and the point of circuit origin.

C. The electrical work includes the installation or connection of certain materials and equipment furnished by others. Verify all connection details.

D. All equipment over 50 pounds shall be provided with adequate lifting means.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 ACCESS TO EQUIPMENT

A. Starters, switches, receptacles, pull boxes, etc. shall be located to provide easy access for operation, repair and maintenance. If the devices listed above are concealed, access doors shall be provided.

3.2 SUBMITTALS

A. Operation and Maintenance Manuals: Operation and Maintenance Manuals shall be provided according to Division 1 requirements. In general, during the time of the contract, and before substantial completion of the electrical installation, submit to the Architect/Engineer three (3) copies of descriptive literature, maintenance recommendations (from the equipment manufacturer), data on initial operation, wiring diagrams, performance curves, engineering data and tests, operating procedures, routine maintenance procedures, and parts lists for each item of electrical equipment installed under this contract and submit all manufacturer's guarantees and warranties.

B. Shop Drawings: The Contractor shall furnish shop drawing portfolios and proper transmittal forms for all materials, equipment, and lighting fixtures to be incorporated in the work in accordance with the General Conditions, Supplementary Conditions, and all other applicable Conditions.

1. Shop drawings on component items forming a system or that are interrelated shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function properly as a system. A notation shall be made on each shop drawing submitted as to the item's specific use, either by a particular type number referenced on the drawings or in the specifications, by a reference to the applicable paragraph of the specifications, or by a description of its specific location. The shop drawings shall be organized and bound into sets with each set collated.
2. The Architect/Engineer shall have the final authority as to whether the equipment or material submitted is equal to the specified item. Proposed substitutions may be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

3.3 EXISTING UTILITIES

A. The Contractor shall verify the location of all existing utilities with the Owner and Utility Companies prior to commencing excavation work. The drawings and survey data of the contract documents indicate the available information on the existing power and communication services, and on new services to be provided to the project by utility companies. Accuracy of this information is not assured.

3.4 ELECTRICAL SERVICE

A. The Contractor shall provide all material and pay all fees required by the local utility company for the connection of the new electrical service as shown on the plans. The Contractor shall also meet all equipment requirements of the local utility company. The Contractor shall provide all necessary materials for construction of the temporary electrical service and shall coordinate all details with the local utility company.

3.5 TELECOMMUNICATIONS SERVICE

A. The telecommunications services to the building are as indicated on the drawings. Arrange all service details with the local telecommunications companies and pay all costs and fees assessed to the project. All work shall be in accordance with the local telecommunications companies'

standards and subject to their approval. Coordinate the installation of service entrance equipment with the telecommunications companies prior to the start of construction.

3.6 SMOKE AND SMOKE/FIRE DAMPERS

A. Provide all necessary connections, including power supply circuits (fed from the nearest panelboard of the appropriate voltage) to smoke dampers and smoke/fire dampers so that upon fire alarm conditions or integral smoke detector activation, the dampers close. Coordinate damper and control locations with the mechanical and controls contractors. Refer to the mechanical drawings for damper schedule and locations. Connect to emergency backup power.

3.7 ELECTRICAL-MECHANICAL EXTENT OF WORK

A. The responsibility of work specified under Divisions 21, 22, 23 and 26 is clarified under, Sections 210500, 220500 and 230500. Said Sections areincorporated herein by reference.

3.8 ELECTRICAL PRODUCT COORDINATION

A. Refer to Division 2 through Division 32 and the electrical drawings for the power characteristics required and available for the operation of each power-consuming item of equipment. Coordinate purchases to ensure uniform interface with every item requiring electrical power.

3.9 CUTTING AND PATCHING

A. The Electrical Contractor shall be responsible for all cutting and patching of holes in building construction which are required for the passage of electrical work. Cutting and patching shall conform to the requirements of Division 1 and, if applicable, Division 2 of these specifications.

B. Cutting of structural framing, walls, floors, decks and other members intended to withstand stress is not permitted.

3.10 PAINTING, FINISHING

A. Painting of electrical work exposed in occupied spaces, except mechanical and electrical machine rooms and maintenance/service spaces; and work exposed on the exterior of the facility is specified and performed under other divisions of these specifications.

B. Factory finishes, shop priming, and special protective coatings are specified in the individual equipment specification sections.

C. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.

3.11 EXCAVATION AND BACKFILLING

A. Contractor shall perform all excavation and backfilling necessary to install the required electrical work. Coordinate the work with other excavating and backfilling work in the same area. Except as indicated otherwise, comply with the applicable sections in Division 31 of these specifications,

excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.

B. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Contractor.

3.12 CONDUITS AND SUPPORT, GENERALLY

A. Conduits, except electrical conduits run in floor construction, shall be run parallel with or perpendicular to lines of the building unless otherwise noted on the drawings. Electrical conduits shall not be hung on hangers with any other service, unless specifically approved by the Engineer. Electrical conduits shall be hung above all other service pipes. Hangers on different service lines running close to and parallel with each other shall be in line with each other and parallel with, or perpendicular to, the lines of the building. Exact location of electric outlets, piping, ducts, and the like shall be coordinated to avoid interferences between lighting fixtures, piping, ducts, and similar items.

3.13 ACCESS PANELS

A. Furnish and install panels for access to junction boxes and similar items where no other means of access, such as a readily removable, sectional ceiling is shown or specified.

B. Panels shall not be less than 12-inches by 16-inches in size. Larger panels shall be furnished where required. Panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Access panels shall be flush type and of all steel construction, with a No. 16 gauge wall or ceiling frame for masonry or plaster and a No. 14 gauge panel door. Doors shall be secured with concealed hinges and flush locks of either the cylinder type or approved, positive acting, screwdriver operated type. Doors for wall panels may be secured with suitable clips and countersunk screws. Panels shall be painted with a rust-inhibitive primer at the factory. Panels in rated wall shall also be rated.

3.14 INSTALLATION OF EQUIPMENT

A. Install and connect all appliances and equipment as specified and indicated for this project, in accordance with the manufacturers' instructions and recommendations. Furnish and install complete electric connections and devices as recommended by the manufacturer or required for proper operation.

3.15 COORDINATION

A. Coordinate the electrical work with work of the different trades so that:
   1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
   2. Within the limits indicated on the drawings, the maximum practicable space for operation, repair, removal and testing of electrical and other equipment will be provided.
   3. Pipe, conduits, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, conduits, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

B. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

C. Before any sleeves or inserts are set, or any electrical equipment or foundations are installed, prepare and submit for approval composite coordination drawings for all equipment rooms, and other areas in which work of two or more trades or subcontractors is to be installed and in which the probability of interference exists. Drawings shall show the work of all trades covered, shall be drawn to a scale not smaller than 1/2" = 1'-0", and shall show clearly in both plan and elevation that all work can be installed without interference.

D. Any work installed prior to approval of coordination drawings shall be at the Contractor's risk. Subsequent relocations required to avoid interference's shall be made without additional expense to the Owner.

3.16 SINGULAR NUMBER

A. Where any device or part of equipment is herein referred to in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

3.17 WARRANTY

A. Refer to the General Conditions section of this Specification for warranty requirements and information.

3.18 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Sequence operations properly so that all work of this project will not be damaged or endangered. Operate each item of equipment and each system in a test run of appropriate duration to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Conduct a full-day walk-through instruction seminar for the Owner's personnel to be involved in the continued operation and maintenance of electrical equipment and systems. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, security, safety, efficiency and similar features of the systems.

C. At the time of substantial project completion, turn over the prime responsibility for operation of the electrical equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

3.19 SUBSTITUTIONS

A. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified by name and/or manufacturer. Substitutions, for materials or items of equipment specified, will not be allowed, unless approved by Engineer prior to (14 days before) bid date.

B. Refer to Instructions to Bidders for complete requirements for substitutions.

3.20 AS-BUILT DRAWINGS

A. Contractor shall provide the Owner with as-built drawings for all electrical systems as described in these specifications and/or shown on the Drawings.

END OF SECTION 260500

MOTOR TEST REPORT

DATE:_____
SHEET NO. _____ OF _____

PROJECT NAME: _____
PROJECT NUMBER:_____

DESIGNATION						
LOCATION						
HORSEPOWER						
NEMA STARTER SIZE						
MAXIMUM HEATER AMPS						
MEASURED	PHASE			PHASE		
CONDITIONS	**A**	**B**	**C**	**A**	**B**	**C**
ACTUAL MOTOR CURRENT						
NAMEPLATE MOTOR CURRENT						
NO LOAD VOLTAGE						
FULL LOAD VOLTAGE						

DESIGNATION						
LOCATION						
HORSEPOWER						
NEMA STARTER SIZE						
MAX HEATER AMPS						
MEASURED	PHASE			PHASE		
CONDITIONS	**A**	**B**	**C**	**A**	**B**	**C**
ACTUAL MOTOR CURRENT						
NAMEPLATE MOTOR CURRENT						
NO LOAD VOLTAGE						
FULL LOAD VOLTAGE						

ELECTRICAL TEST REPORT

DATE:_____
SHEET NO. _____ OF _____

PROJECT NAME: _____
PROJECT NUMBER:_____

SERVICE TRANSFORMER SIZE	
NO LOAD SERVICE VOLTAGE	
FULL LOAD SERVICE VOLTAGE	

DESIGNATION									
LOCATION									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									

DESIGNATION									
LOCATION									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									

SECTION 26 05 01 – BASIC MATERIALS AND METHODS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. The extent of Basic Materials and Methods is indicated by the drawings and specifications. Basic materials are defined but not limited to cable and conduit seals, outlet boxes, pull boxes, conduit fittings, safety switches, lockout pushbuttons and fuses.

1.3 QUALITY ASSURANCE

A. Manufacturers: All materials shall be new, unused, and unweathered, and of the quality specified. Materials shall be standard products of manufacturer's regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design.

B. Installer: All equipment and materials shall be installed in a neat and workmanlike manner, shall be complete in both effectiveness and appearance, whether finally concealed or exposed and shall be executed by experienced mechanics.

1.4 REFERENCES

A. The electrical work shall conform to all applicable sections of standards, codes and specifications promulgated by organizations listed below.

1. Occupational Safety and Health Standard, National Consensus Standards and Established Federal Standards
2. National Electrical Code (NEC)
3. National Electric Manufacturer's Association (NEMA)
4. American Society for Testing of Materials (ASTM)
5. Underwriters Laboratories, Inc. Standards (UL)
6. Factory Mutual Engineering Corporation or other Recognized National Laboratories

1.5 SUBMITTALS

A. Shop drawings: Prepare a set of shop drawings showing manufacturers product data for all component parts specified in this Section.

2. PRODUCTS

2.1 Equipment and Materials Furnished by Others: Certain materials and equipment for this project will be furnished under other divisions. These materials and equipment, which are shown or noted on the plans, will be installed and/or connected under this Division. It shall be incumbent upon this Contractor to become familiar with all of the materials and equipment that will be furnished under other Divisions, but which will be installed and/or connected under this Division.

2.2 Cable and Conduit Seals: Seals shall be provided around all conduits and cables which penetrate smoke walls, fire walls, and floors. Nelson Flameseal System shall be used to seal penetrations of electrical cables and conduits.

A. Materials used shall be flameseal putty, ceramic fiber insulation and where rigid support on large oversized openings is required, ceramic fiber board. Board shall be rigid and able to withstand temperatures in excess of 2000 degrees F.

B. Accessory hardware shall be provided as required on oversized openings.

C. Follow manufacturer's instructions in selecting the type of seals and accessories. Also follow the manufacturer's instructions on installation of the cable and conduit seals. Equal quality equipment by OZ Gedney and 3M shall be acceptable.

2.3 Outlet Boxes, Pull Boxes and Conduit Fittings: Furnish and install outlet boxes, pull boxes, and conduit fittings as described below. Catalog numbers shown are Appleton Electric Company; Steel City, O.Z. Gedney, and Raco, are equally acceptable.

A. OUTLET BOXES

1.	Lighting Boxes (concealed)	No. 40-3/4
2.	Lighting Boxes (concrete)	OCR Series
3.	Lighting Boxes (exposed)	4S-3/4 or 40-3/4
4.	Flush Switches, Receptacles Telephone and Flush Junction Boxes	No. 4S-3/4 with separate extension plaster ring; M*-250 in masonry construction (* refers to number of devices in the box)
5.	Weatherproof type Switch, Receptacle and Telephone Boxes (exposed)	FS Series w/FS cover and neoprene gasket.
6.	Switch, Receptacle and Telephone Boxes (exposed)	4S-3/4 with 8360 or 8370 series raised surface cover.

B. Where space is limited, No. 4CS-3/4 handy boxes may be used for switch, receptacle and telephone outlets with specific approval only.

C. Extension and plaster rings shall be installed as required by the NEC.

D. Outlet boxes shall comply with the National Electrical Code in regard to the allowable fill.

2.4 PULL BOXES

A. Pull boxes shall be fabricated of code gauge galvanized sheet metal and shall be sized in accordance with the National Electrical Code requirements or as shown on the drawings. Provide removable cover on the largest access side of the box. In-line conduit pull boxes may be O.Z., Type PBW, or equal. Provide pull boxes at all code required locations, and as needed to aid in cable pulling.

2.5 SAFETY SWITCHES

A. Furnish and install heavy duty type safety switches, having the electrical characteristics, ratings and modifications shown on the drawings. All switches shall have:

B. NEMA 1 general purpose enclosures unless otherwise noted for all interior applications;

C. NEMA 3R rainproof enclosures unless otherwise noted for all exterior applications;

D. Metal nameplates, front cover mounted that contain a permanent record of switch type, catalog number and H.P. ratings with both standard and time delay fuses;

E. Handle that is padlockable in "OFF" position;

F. Non-teasible, positive quick-make, quick-break mechanism;

G. UL approval and shall bear the UL label;

H. All fusible switches shall have Class R Fuse rejection clips.

I. Safety switches, as manufactured by the following, will be equally acceptable, but all safety switches furnished by this Contractor shall be the product of one manufacturer:

1. Square D Company
2. General Electric
3. Cutler Hammer
4. Siemens

2.6 FUSES

A. Fuses shall be furnished and installed in each fused switch, and shall be rated as shown on the drawings.

B. Provide fuses according to the following and in accordance with recommendations of manufacturers whose equipment is being protected:

1. Provide UL Class L current limiting time-delay fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting transformers, motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
2. Provide UL Class L current limiting fast-acting fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit breakers. (Similar to Buss Limitron fuses.)
3. Provide UL Class RK1 current limiting, dual-element, time-delay fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
4. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
5. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, 1 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting circuits with no heavy inrush current where reduced dimension devices are required.
6. Provide UL Class H fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 10,000A RMS symmetrical interrupting current rating for protecting general purpose light duty feeders.
7. Provide UL Class T fuses rated 600-volts, 60 Hz, 1 to 1,200 amps, with 200,00A RMS symmetrical interrupting current rating for protection of non-motor loads where reduced dimension devices are required.

C. Three spare fuses shall be furnished for each size and type used. Each fused switch shall be provided with a mastic backed label clearly identifying the type and size of fuse required.

3. EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL

A. Except where more stringent requirements are indicated, comply with product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing.

3.2 MOUNTING HEIGHTS

A. Mounting heights to the center of the box above finished floor for the items listed below shall be as follows, unless otherwise shown. All other device mounting heights shall be as shown on the drawings. All devices shall be mounted in accordance with ADA (Americans with Disabilities Act) requirements.

B.	Flush tumbler switches	48"
C.	Switches in concrete block	46"
D.	Switches over wainscot	6" above 48" wainscot
E.	Convenience outlets	18" mounted vertically with ground prong slot at bottom
F.	Safety switches	54"
G.	Motor controllers	54"
H.	Panelboards to top	72"
I.	Telephone Outlets	18"
J.	Telephone outlets (pay and wall type)	54" for non-ADA type 44" for ADA type
K.	Bracket lights (120 volt)	84"
L.	Bracket lights (277 volt)	96"
M.	Clock outlets 8' ceiling 9' ceiling	84" 96"
N.	Receptacles above counters	6" above counters mounted (horizontally)-(vertically)
O.	Convenience outlets in mechanical, electrical, janitor and elevator machine rooms	48”
P.	Telephone panels	72" to top
Q.	Exterior W.P. convenience outlets	24" above grade mounted (horizontally) - (vertically)
R.	Capacitors furnished by Mech.	36" minimum
S.	Lock-out push button	36" minimum
T.	Fire alarm pull station	48"
U.	Fire alarm horn, bell chime or light	80"
V.	Intercom System Pushbutton Stations	48"

W. Contractor shall check all equipment layouts and verify exact mounting heights.

3.3 CUTTING AND PATCHING FLOORS, WALLS OR CEILINGS

A. Cutting, patching, repairing, and finishing of carpentry work, metal work, or concrete work, etc., which may be required for this work shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner as not to weaken walls, partitions, or floors. Holes required to be cut in floors must be drilled without breaking out around the holes. Cutting, patching, and painting shall conform to the requirements of the General Conditions section of this Specification.

B. Cutting of structural framing, walls, floors, decks, or other members intended to withstand stress is not permitted.

C. Sleeves through floors or walls shall be black iron pipe and shall be flush with finished faces of floors, walls or ceilings. Sleeves shall be sized to accommodate raceways indicated.

D. Use care in piercing water proofing. After the part piercing the waterproofing has been set in place, seal openings, and make absolutely watertight.

3.4 SLEEVES

A. Sleeves shall be used to accommodate conduit or tubing where conduit or tubing pass through newly poured concrete walls or slabs.

B. All sleeves through floors and walls shall be black iron pipe, flush with walls or finished floors; and of sizes to accommodate the raceways shown. Sleeves through outside walls above grade shall be caulked with approved caulking compound. Sleeves shall not be required through on grade slabs.

C. For raceways which enter buildings below grade, install manufactured floor and thruwall seals, similar to Type "FSK" or "WSK" as manufactured by O.Z. Electric Manufacturing Co.

3.5 INSTALLATION METHODS

A. Conductors shall be installed in concealed raceways except as shown otherwise on the drawings or specified to be otherwise in these specifications. Exposed conduits and wires shall be installed parallel or perpendicular to building surfaces. Conduits and wires in the space above ceilings shall be supported adequately and shall not be laid on the top of ceiling systems. Conduits and wires installed above ceilings shall be considered exposed.

B. Electrical conduits shall not be hung on hangers with any other service foreign to the electrical systems, nor shall they be attached to other foreign services.

C. The lighting and power branch circuit conductors shall be installed in separate raceway systems unless specifically shown or noted otherwise.

D. Equipment Bases. Provide concrete equipment bases for all floor mounted equipment furnished under this contract. Concrete bases shall be 3-1/2"-inches high unless noted otherwise and shall extend 3-inches beyond all sides of the unit. Trowel all edges at a 45 degree angle. This work shall be done in accordance with Division 3 of the specifications by the Division 16 Contractor. Bases shall be provided for switchboards, motor control centers, transformers and all other floor mounted equipment.

E. Outlet Box Locations. Outlet boxes shall be located so they are not placed back-to-back in the same wall, and in metal stud walls, are separated by at least one stud space in order to limit sound transmission from room to room. Outlet boxes installed on opposite sides of fire rated walls shall be spaced at least 24" apart.

3.6 WIRING - NUMBER OF WIRES REQUIRED

A. The number of wires for lighting and receptacle branch circuits are not shown on the drawings. The number of wires in any circuit is determined in accordance with the National Electrical Code, and wiring is provided to perform all functions of the devices being installed. Additionally, wires shall be provided as required by the contract documents, i.e. equipment grounds, etc. Provide the number of wires required for a complete and workable system.

3.7 PROTECTION FROM WEATHER

A. Raceway stub ups shall be capped or otherwise protected from moisture and debris until such time that the conductors are pulled. Conductors shall not be installed in raceways until the building is protected from the weather, all concrete and plastering is completed, and raceways in which moisture has collected have been swabbed or blown out.

3.8 ELECTRICAL ROOM COORDINATION

A. Where a number of electrical panels and/or related electrical items are shown, the Electrical Contractor shall coordinate the physical sizes with his equipment suppliers to ensure that there is adequate space for the items shown to be installed in those areas and that all Code required clearances are maintained.

B. The Contractor shall rearrange the equipment layout to achieve full use of the available space prior to installing conduit stub ups. Where a conflict or rearrangement exists, the Contractor shall submit a proposed revised layout of the area to the Architect.

3.9 NAMEPLATES

A. Nameplates shall be provided for all items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards and motor control centers, control devices and other significant equipment

B. Nameplates shall be 1"x 2-1/2" laminated black phenolic resin with a white core with engraved lettering, a minimum of 3/16-inch high. Manufacturers factory installed nameplates shall be acceptable provided all information is furnished.

C. Nameplates shall identify the equipment item that the device is serving and also from where the device is being fed from. Nameplates shall also identify the system voltage of the item of equipment.

3.10 RACEWAY SUPPORTS

A. Raceways shall be securely supported and fastened in place with pipe straps, wall brackets, caddy clips, hangers or trapeze hangers at intervals specified in Section 260533 "RACEWAYS" or:
   1. As shown on the drawings.
   2. As may be required by special adverse field conditions.

B. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws or welded threaded studs on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine wood screws. Threaded C-clamps shall not be used. Raceways or pipe straps shall not be welded to steel structures. Holes cut in reinforced concrete beams or in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used, and bar hangers may be attached with saddle ties of not less than No. 16 AWG double strand zinc-coated steel wire. No raceway shall be attached to the suspended ceiling construction. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts and insulating bushings.

3.11 BOX SUPPORTS

A. Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Plastic expansion shields shall not be used. Threaded studs driven in by powder charge and provided with lockwashers and nuts may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Raceways shall be supported with an approved type fastener not more than 24-inches from the box. Penetration into reinforced concrete beams and into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

3.12 LIGHTING FIXTURE SUPPORTS

A. Lighting fixtures shall be supported as follows and in accordance with all applicable Codes and Regulations:
   1. By fixture studs or other devices securely attached to outlet box, or;
   2. By special hangers designed and intended for use as lighting fixture supports, or;
   3. By a special clip or device attached to the ceiling system grid designed to secure the lighting fixture in place or;
   4. By other methods and devices designed and intended for use as lighting fixture support, or;
   5. As shown on the drawings.

B. The lighting fixture support system detail shall be submitted with and be a part of the lighting fixture shop drawing submittal.

C. Lighting fixtures shall <u>not</u> be supported from the leg of pre-cast pre-stressed concrete.

END OF SECTION 260501

SECTION 26 05 19 – CONDUCTORS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work in this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 16 section making reference to conductors.

1.2 Description of Work: Extent of electrical wire and electrical cable work is indicated by drawings and schedules. Types of wire, cable and connectors in this Section include the following:

A. Copper conductors

B. Power-limited circuit cable

C. Service entrance cable

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of electric wire and cable products of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical wiring work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable and connectors.

B. UL Compliance: Comply with UL standards pertaining to wire cable and connectors.

C. UL Labels: Provide electrical wires, cables and connectors which have been UL-listed and labeled.

D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association Standards pertaining to materials, construction and testing of wire and cable.

E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.

F. IEEE Compliance: Comply with applicable portions of IEEE standards pertaining to wire and cable.

G. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

A. Submit manufacturer's data on electric wire and cable.

2. PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable and connector):

A. WIRE AND CABLE:

1. Advance Wire and Cable, Inc.
2. Cerro Wire and Cable, Co.
3. Electrical Conductors, Inc.
4. General Cable Corp.
5. Hitemp Wires, Inc.
6. Rome Cable Corp.
7. Southwire Company
8. The Okonite Company

B. CONNECTORS:

1. Amp, Inc.
2. Burndy Corp.
3. Eagle Electric Mfg. Co., Inc.
4. Gould, Inc.
5. Ideal Industries, Inc.
6. Josylyn Mfg. and Supply Co.
7. O-Z/Gedney Co.
8. Pyle National Co.
9. Thomas and Betts Co.

2.2 WIRE, CABLE, AND CONNECTORS

A. General: Except as otherwise indicated, provide wire, cable and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, and as required for the installation.

B. WIRE:

1. All conductors shall be 600-volt and shall be copper with insulation of the following types, unless otherwise noted on the drawings or in these specifications.
2. For dry locations, provide Type THHN conductors. Conduit sizes are based on type THHN wire.
3. For damp or wet locations, provide Type THWN conductors.
4. Provide Type THWN conductors for service entrance cabling or feeders direct buried, or installed in underground raceways. Provide Type THWN conductors for branch circuit conductors installed in underground raceways.
5. No wire shall be smaller than No. 12 AWG, except that wiring for signal and pilot control circuits may be No. 14 AWG, and pre-manufactured fixture whips for light fixtures may be No. 14 AWG.
    a. Use preinsulated connectors 3M Company "Scotchlok," or Ideal Industries, Inc. "super nut," for splices and taps in conductors No. 10 AWG and smaller. All other twist-on connectors must be reviewed by the Architect prior to installation. Use this type of connector for factory-made splices in fixtures or equipment.
    b. Pressure indent type connectors must be submitted to the Architect for review.
    c. Tape all splices and joints with vinyl plastic tape manufactured by Minnesota Mining and Manufacturing Company. Use sufficient tape to secure insulation strength equal to that of the conductors joined.
    d. Keep splices in underground junction boxes to an absolute minimum. Where splices are necessary, use resin pressure splices and resin splicing kits manufactured by the 3M Company, St. Paul, Minnesota, to totally encapsulate the splice. Arrange the splicing kit to minimize the effects of moisture.
6. Connect wire No. 6 AWG and larger to panels and apparatus by means of approved lugs or connectors.
7. All wire No. 8 AWG and larger shall be stranded.
8. Connectors of the porcelain cup type with or without metal inserts shall not be used, including all splices in fixtures which are made in advance by the fixture manufacturer. Splices in wire

No. 8 AWG and larger shall be made with approved solderless lugs. If any type of pressure indent type connector is proposed for use on any size conductor, it shall be specifically submitted for approval prior to use.

9. Wire sizes shown are minimum based on code requirements, voltage drop and/or other considerations. Larger sizes may be installed at the Contractor's option to utilize stock size, provided conduit sizes are increased where necessary to conform to the National Electrical Code. Sizes of wires and cables indicated or specified are American Wire Gage (Brown and Sharpe).
10. All feeder and branch circuit wiring shall be color-coded as follows:

PHASE	120/208 VOLT	277/480 VOLT
A	Black	Brown
B	Red	Orange
C	Blue	Purple
Neutral	White	*White
Ground	Green	Green

*Except as provided in paragraph 210-5 of the NEC.

3. EXECUTION

3.1 INSTALLATION

A. General: Install electric cables, wires and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

C. Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized wherever required.

D. Splicing: No splicing or joints will be permitted in either feeder or branch circuits except at outlet or accessible junction boxes.

E. Wire shall not be installed in raceways until the concrete work and plastering is completed and all conduits in which moisture has collected have been swabbed out. Insulation resistance to ground shall not be less than that approved by NEC. Eliminate splices wherever possible.

F. Use pulling compound or lubricant where necessary. Compound must not deteriorate conductor insulation.

G. Prior to energization, check cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.

H. Bury a continuous, pre-printed, bright colored plastic ribbon cable marker with each underground cable, regardless of whether conductors are in conduit. Locate each directly over cables 12" below finished grade.

I. Conductor Installation: Install all conductors in a single raceway at one time, insuring that conductors do not cross one another while being pulled into raceway. Leave sufficient cable at all fittings or boxes and prevent conductor kinks. Keep all conductors within the allowable tension and exceeding the minimum bending radius.

J. Conductor Support: Provide conductor supports as required by the code and recommended by the cable manufacturer. Where required, provide cable supports in vertical conduits similar to OZ Type C.M.T., and provide the lower end of conduit with OZ Type KVF ventilators.

K. Conductor Termination: Provide all power and control conductors, that terminate on equipment or terminal strips, with solderless lugs or fork and flanged tongue terminals. Provide T and B "sta-kon" tongue terminal. This type conductor termination is not required when the equipment is provided with solderless connectors.

L. Many circuits are shown on the drawings to be provided with dedicated neutral and ground conductors. Carefully review circuiting and the electrical abbreviations and symbols legend and provide the number of conductors indicated.

END OF SECTION 260519

SECTION 26 05 33 - RACEWAYS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 26 section making reference to electrical raceways specified herein.

1.2 DESCRIPTION OF WORK

A. Extent of raceways is indicated by drawings and schedules.

C. Types of raceways in this Section include the following:

1. Electrical metallic tubing.
2. Flexible metal conduit.
3. Intermediate metal conduit.
4. Liquid-tight flexible metal conduit.
5. Rigid metal conduit.
6. Rigid nonmetallic conduit.
7. Surface metal raceways.

1.3 REFERENCES

A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Each length of raceway shall bear the Underwriters Laboratories label.

C. NEC Compliance: Comply with NEC requirements which are applicable to the construction and installation of raceway systems.

D. NECA Compliance: Comply with NECA's "Standard of Installation".

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway required.

2. PRODUCTS

2.1 STEEL CONDUIT

A. Steel Conduit: Rigid steel conduit, intermediate metal conduit and steel electrical metallic tubing shall be hot-dipped, galvanized or sheradized as manufactured by Youngstown Sheet and Tube Company, National Electric, General Electric, or equal.

B. Joints: Raintight non-insulated throat type steel compression fittings (connectors and couplings) shall be provided for electrical metallic tubing systems. All fittings shall be of the steel type with

steel locknuts equal to Appleton 95 Series. In dry locations steel set screw connectors/couplings are acceptable.

C. Expansion Joints: Provide expansion fittings, O.Z. Type AX with bonding jumper for rigid conduit and O.Z. Type TX with bonding jumper for electrical metallic tubing. Where embedded raceways cross building expansion joints, provide combination deflection/expansion fittings, O.Z. Type AXDX, or equal.

2.2 ALUMINUM CONDUIT

A. Aluminum Conduit: Rigid aluminum conduit and elbows shall be extruded from primary 6063 aluminum alloy to a T42 temper. The maximum copper content shall not exceed one-tenth of one percent. A petroleum base lubricant containing powered zinc shall be factory applied to the threads at both ends of the conduit. The interior surfaces of conduit and elbows shall be coated at the factory with silicone or an equally effective lubricant to facilitate fishing and wire pulling. Couplings shall be forged from primary 6063 aluminum alloy, threaded, and chamfered. Rigid aluminum conduit, elbows, and couplings shall be Kaiser KINGFISHER as manufactured by Kaiser Aluminum & Chemical Corporation, Aflex Corporation, Reynolds Metals Company, or equal. Unless otherwise noted or specified, aluminum conduit may only be used for raceways 2 inches in diameter, or larger.

2.3 RIGID NON-METALLIC (PVC) CONDUIT

A. PVC (polyvinyl chloride) Conduit: Heavy wall rigid PVC conduit shall be composed of high impact PVC and shall conform to industry NEMA Standards and to Federal Specification WC-1094. Conduits shall be Carlon Schedule 40 type, or approved equal.

2.4 FLEXIBLE METAL CONDUIT

A. Flexible metal conduit shall conform to UL1. It shall be formed from continuous length of spirally-wound, interlocked zinc-coated strip steel.

2.5 LIQUID-TIGHT, FLEXIBLE METAL CONDUIT

A. Liquid-tight flexible metal conduit shall be constructed of a single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; and coated with an oil-resistant, liquid-tight thermoplastic jacket.

2.6 WIREWAYS

A. General: Provide electrical wireways of types, grades, sizes, weights (wall thicknesses), and number of channels for each type service indicated. Provide complete assembly of wireways including, but not necessarily limited to couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for a complete system. Where types and grades are not indicated, provide proper selection as determined by the Installer to fulfill wiring requirements and comply with applicable provisions of NEC for electrical raceways.

C. Surface Metal Raceways: Provide surface metal raceways of sizes and channels indicated; in compliance with FS W-C-582. Construct of galvanized steel with snap-on covers, with 1/8" mounting screw knockouts in base approximately 8" o.c. Provide fittings indicated which match and mate with raceway. Finish with manufacturer's standard prime coating suitable for painting. Provide all necessary devices as shown on the drawings for a complete installation.

D. Manufacturers: Subject to compliance with requirements, provide surface metal raceways of one of the following:

1. B-Line Systems, Inc.

2. Midland-Ross Corporation
3. Power-Strut Division; Youngstown Sheet and Tube Company
4. Johnson Plastic Division; Johnson Rubber Company
5. Square D Company
6. Versa-Tech Corporation
7. Walker/Parkersburg Division; Textron, Inc.
8. Wiremold Company

3. EXECUTION

3.1 GENERAL

A. Install electric raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation" and complying with recognized industry practices.

B. Raceways embedded in concrete or in earth below floor slabs shall be rigid steel conduit, intermediate metal conduit or rigid schedule 40 PVC conduit. Rigid PVC conduit shall be provided with rigid metal or intermediate metal conduit elbows when the raceway system exits the concrete topping or earth.

C. Electrical metallic tubing shall not be embedded in concrete or installed in earth.

E. Aluminum conduit shall not be embedded in concrete, or installed in earth.

F. Rigid heavy wall Schedule 40 PVC conduit shall be installed in earth and concrete only.

G. Raceways in outside walls or in refrigerated areas shall be rigid steel conduit, or intermediate metal conduit.

H. Provide rigid steel conduit or intermediate metal conduit for exposed raceways from floor to eight feet above the floor in mechanical rooms and in areas designated on the plans.

I. Rigid galvanized steel conduit or galvanized intermediate metal conduit shall be used where conduit is exposed to weather.

J. Conduits in hazardous locations shall conform to the National Electrical Code. Rigid galvanized steel conduit or intermediate metal conduit shall be used in hazardous locations. PVC conduit shall not be used in hazardous areas.

K. Rigid metal, intermediate metal, electric metallic tubing or PVC conduit where allowed in other section 3.1 paragraphs shall be used for feeders and branch circuits.

L. Flexible metal conduit may be used to connect light fixtures in accordance with NEC requirements. Provide flexible metal conduit for connections to motors, transformers, generators, and other equipment subject to vibration. Length of flexible conduit shall be a minimum of one foot for conduit diameters up to 1-1/2". A minimum of 3" of flexible conduit shall be added for every 1/2" increase in conduit diameter. Flexible metal conduit installation shall be kept to a minimum in connecting other electrical equipment items. Sealtight, flexible conduit shall be used where the flexible conduit may be subject to moist or humid atmosphere, corrosive atmosphere, subject to water spray and subject to dripping oil, grease or water.

N. Conduits shall be 3/4" diameter, minimum. Raceway sizes shown on the drawing are based on type THHN/THWN conductors.

O. Type Material: Except as noted otherwise all conduit shall be steel.

3.2 INSTALLATION

A. All raceways shall be installed concealed except where shown or noted otherwise.

B. At the Contractor's option, concealed raceways may be embedded in concrete, except as noted otherwise, or installed in furred spaces above ceilings or behind walls.

C. Continuity: Provide metallic raceways continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Enter and secure conduit to all boxes to provide electrical continuity from the point of service to outlets. Provide double locknut and bushing on terminals of metallic conduits.

D. In duct banks a 1/4" diameter nylon rope shall be installed in all empty conduits to facilitate future installation of cabling.

E. Provide accessible "seal-off" fittings for all raceways entering or leaving hazardous areas, entering or leaving refrigerated areas and as otherwise required by the National Electrical Code.

F. Where conduits penetrate the roof seal, they shall be installed in curbs provided for mechanical equipment. When this is not possible, suitable pitch pockets, lead flashing, or approved fittings shall be provided. Details for special conduit installations shall be as shown on the drawings.

G. Reinforced Concrete: No reinforcing steel shall be displaced to accommodate the installation of raceways and outlet boxes. Outlet boxes shall not be installed in beams or joists. In general, all embedded conduits shall be located in the physical center of the particular section of concrete. Unless otherwise indicated, raceways embedded in reinforced concrete shall conform to the following usual types of conditions. Particular attention is called to the fact that there are many extenuating conditions where the Contractor may be instructed in writing during the course of the project not to place embedded conduits in certain areas, generally due to the possibility of unsightly cracking or for structural reasons. This instruction shall not entitle the Contractor to extra compensation. Any condition not covered by the following usual conditions shall require special clarification.

Location	Maximum Allowance
1. Columns	Displacement of 4 percent of plan area of column.
2. Floors and Walls	Displacement of 1/3 of thickness of concrete spaced not less than three diameters on center.
3. Beams and Joists	Displacement of 1/3 of least dimension, spaced not less than three diameters on center.
4. Sleeves thru Floors and Walls	2" maximum pipe size, not less than three diameters on center.

H. Plain Concrete: Raceways shall not be placed in plain concrete, such as cement toppings on structural floors without special instructions.

I. Furred Spaces: Raceways installed in furred spaces shall be installed in accordance with the requirements of the National Electrical Code. Do not anchor or strap conduits to the ceiling furring channels or attach to furred ceiling hanger wires. Raceways may be attached to the suspension system (wire hangers) of drop ceilings if installed in such a manner that the ceiling panels may be removed without interference with the raceway, and the wire hangers are sized to carry the additional raceway load.

J. Stub Ups: Extend conduit stubs at least one foot above slab or fill, before connection is made to electrical metallic tubing.

K. Exterior Conduits: Install raceways a minimum of 42" below finished grade. Encase service conductors and medium voltage duct banks in concrete.

L. Provide marking of conduit and junction boxes to indicate which distribution system they are serving. The markings could be colored tape on conduit at or near junction boxes with different colored tapes indicating different distribution systems. Concealed junction boxes shall be legibly marked with a magic marker to indicate the panel and circuit number that junction box serves.

1. The distribution systems shall be color coded as follows:

    a. Fire Alarm - Red
    b. Nurse Call - Yellow
    c. Paging System - Blue
    d. 120/208 Volt - Green
    e. 277/480 Volt - Orange
    f. Cable TV System - Black
    g. Telephone System - White

M. Steel Conduit (galvanized rigid steel, IMC or EMT):

1. Cutting: Cutting shall be done with hand or power hacksaws. All cut ends shall be reamed to remove burrs and sharp edges.
2. All threaded joints shall be made up wrench-tight and all compression joints shall be made up mechanically secure and snug so as to make continuous current-carrying electrical contact.
3. All metallic conduits buried or otherwise in contact with earth shall be painted using one heavy continuous coat of asphalt varnish after assembly of conduit and fittings.
4. Expansion joints shall be installed in steel conduit systems in structures as follows expansion joints are specified elsewhere in the specification):

    a. Where conduit run crosses a building expansion joint.
    b. In any conduit run exceeding 100 feet in length.
    c. Where shown on the drawings.

N. Threads: Clean all threads of rigid or intermediate metal conduit. Coat all male threads of all steel conduit installed in concrete with red or white lead immediately before being coupled together.

O. Running Threads: Use "Erickson" type couplings in lieu of running threads.

Q. Aluminum Conduits:

1. Cutting: Cutting shall be done with hand or power hacksaws. All cut ends shall be reamed to remove burrs and sharp edges.
2. Joints: All joints shall be made up wrench-tight so as to make continuous current-carrying contact. Lubricate all joints before assembly. Use a standard aluminum lubricant recommended by the raceway manufacturer.
3. Wire Pulling: Wire pulling shall be accomplished with round metal tapes, polyethylene ropes or nylon manila ropes.
4. Expansion Joints: Expansion joints shall be installed in structures as follows:

    a. Where conduit run crosses a building expansion joint.
    b. In any conduit run exceeding 75 feet in length.
    c. Where shown on the drawings.

5. Bending: Use hydraulic benders for all sizes of aluminum conduit.
6. Support Spacing: Support conduit, size 2 through 4 inches, a maximum of 7 feet, 6 inches on center. Support conduits 5 inches and larger not less than 5 feet on center.

R. PVC Conduit:

1. Joints: Conduits shall be joined by using couplings and solvent cement furnished or recommended by the raceway manufacturer. Finished joints shall be secure and watertight.
2. Cutting: Cutting shall be done with hacksaws and ends shall be reamed to remove burrs and sharp edges.
3. Expansion Joints: Expansion joints shall be installed:

    a. Where conduit run crosses a building expansion joint.
    b. As recommended by the manufacturer or as shown on the drawings.

4. Bends for PVC conduit sizes 2" and smaller may be made "hot" in the field. Inside dimension shall be thereby undistorted. For PVC sizes larger than 2", provide only factory bends.

S. Concrete Encased Ducts.

1. Provide only where specifically indicated on the drawings or otherwise required by Code.
2. Grade trenches and ducts to provide a minimum of 3 inch slope for each 100 feet of duct.
3. Multiple conduit runs or banks shall be supported on preformed, nonmetallic separators. Any separator containing metal shall have the metal non-continuous and shall not form a magnetic loop in any manner. Spacing between separators shall be close enough to prevent sagging of conduits and breaking of couples and watertight seals. Separators shall also be spaced to keep deformation of conduit at the separators to 0.10 inch or less. Separators shall be secured with cords where necessary and no tie wires, reinforcing rods, or other metallic materials shall be placed around the conduits, either individually or in groups, in such a manner as to form a magnetic loop.
4. Enclose ducts in a minimum 3 inch concrete envelope. Concrete shall be 3000 psi of mixture acceptable to the Architect.
5. Reinforce the concrete envelope at all points where ducts cross fill or loose soil, water, gas sewage mains, under roadways and sidewalks, or elsewhere shown on the drawings. Provide one 3/4 inch reinforcing rod between each two ducts of bottom layer, and one rod laid at each lower corner of cut envelope. Lay rods parallel to ducts, centered between ducts, and placed halfway between bottom of ducts and bottom of concrete envelope. Extend reinforcing a minimum of 5 feet beyond each side of fill or pipe main, and where spliced, provide a lap of 20 diameters. Consult with the Architect, after the trench is excavated, to determine locations requiring reinforcing.
6. Hand "rod" concrete to provide complete encasement of all conduits.
7. After the duct line has been completed, a standard flexible mandrel not less than 12 inches long, having a diameter approximately 1/4 inch less than the inside diameter of the conduit, shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line. Pneumatic rodding may be used to draw in the lead wire. A No. 9 galvanized-iron pull wire free of kinks and splices shall be installed in all unused ducts and shall extend a minimum of three feet into each manhole.
8. All conduits or ducts, active or spares, entering a building or manhole shall be completely and adequately sealed at first termination with oakum or suitable plastic expansible compound to prevent the entrance into the building of rodents, gases, or vapors.

END OF SECTION 260533

SECTION 26 27 26 – WIRING DEVICES

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. This section is a Division 26 "Basic Materials and Methods" section, and is a part of each Division 16 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry, but not utilize electrical energy.

C. Types of electrical wiring devices in this Section include the following:

1. Receptacles
2. Switches
3. Wall Plates
4. Dimmer Controls
5. Floor Outlets
6. Underfloor Duct and Fittings

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of wiring devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less then 3 years.

B. Installer: Qualified with at least 2 years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.

B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.

C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.

D. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical wiring devices.

2. PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products of one of the following:

A. Pass and Seymour Corporation

B. Cooper

C. Hubbell, Inc.

D. Leviton, Inc.

E. Crouse Hinds

F. Wiremold

G. Walker Duct

H. Cellco

I. Lutron

2.2 WIRING DEVICES

A. General: Where shown on the drawings, furnish and install wiring devices indicated by the appropriate symbols. Wiring devices shall be products of Pass and Seymour Corporation, or equal. Catalog numbers shown below are P & S hard use specification grade. Similar devices manufactured by Hubbell or Leviton shall be equally acceptable.

C. Switches: Branch circuit switches shall be flush tumbler (rocker) type as follows:

1.	Single Pole	20AC1 Series - Gray
2.	Two Pole	20AC2 Series - Gray
3.	Three-Way	20AC3 Series - Gray
4.	Four-Way	20AC4 Series - Gray
5.	Single Pole SW With Pilot	20-AC1-RPL Series

6. Switches for emergency systems shall be as shown above, but red in color.
8. Wall Mounted Line Voltage PIR type Occupancy Sensing Switches: Watt Stopper type WA-200 – 120/277 – Ivory with time delay set at 15 minutes
9. Ceiling Mounted Line Voltage Ultrasonic Occupancy Sensing Switches: Watt Stopper type WT-1105 – Ivory with time delay set at 15 minutes with a Watt Stopper B120E-P power pack. Mount power pack above accessible ceiling. Provide all necessary wiring between power pack and occupancy sensor.
10. Wall Mounted Line Voltage Dual Technology Occupancy Sensing Switches: Watt Stopper type DT-200 – Ivory with time delay set at 15 minutes with a Watt Stopper B120E-P power pack. Mount power pack above the accessible ceiling. Provide all necessary wiring between power pack and occupancy sensor.

D. Dimmer Switches: Provide dimmer switches according to the following (all catalog numbers are Lutron Nova T series, unless otherwise noted). At minimum, all dimmer switches shall be rated to accommodate the load shown to be switched on the Drawings.

Incandescent Dimmers	Catalog No.
120 Volt, 600 Watt, Single Pole	NT-600
120 Volt, 1000 Watt, Single Pole	NT-1000
120 Volt, 1500 Watt, Single Pole	NT-1500
120 Volt, 2000 Watt, Single Pole	NT-2000

Incandescent Low Voltage

Dimmers (for transformer supplied low voltage lamps)	
120 Volt, 600 VA (500W), Single Pole	NTLV-600
120 Volt, 1000 VA (800W), Single Pole	NTLV-1000
120 Volt, 1500 VA (1200W), Single Pole	NTLV-1500
Fluorescent Dimmers (for 30 & 40W rapid start lamps with magnetic dimming type ballasts)	
120 Volt, 1 to 10 Lamps, Single Pole	NF-10
120 Volt, 6 to 20 Lamps, Single Pole	NF-20
120 Volt, 14 to 30 Lamps, Single Pole	NF-30
277 Volt, 1 to 12 Lamps, Single Pole	NF-10-277
277 Volt, 6 to 24 Lamps, Single Pole	NF-20-277

2.3 RECEPTACLES

A. All receptacles shall be side and back wired, self-grounding of the type indicated on the drawings, or as follows. Catalog numbers shown below are Pass & Seymour specification grade unless otherwise indicated. Similar devices manufactured by Hubbell or Leviton shall be equally acceptable:

1.	Duplex Convenience Receptacles 20A-125V (Grounding Type)	5362 Series-Gray
2.	Weatherproof Duplex Receptacles 20A-125V (Grounding Type)	5362 WP Series-Gray with Weatherproof F.S. Plate
3.	Duplex GFI Receptacle 20A-125V	2091-Gray
4.	Weatherproof Duplex GFI Receptacle 20A-125 Volt	2091 with 4511 (horizontal) or 4512 (vertical) Weatherproof Wall Plate
5.	Clock Hanger Outlet	S3733-SS
6.	Hospital Grade Receptacle 20A-125 Volt	8300 Gray for Normal Power and 8300 Red for Emergency Power
7.	Hospital Grade GFI Receptacle 20A-125 Volt	2091-HG Gray for Normal Power and 2091-HG Red for Emergency Power
8.	Safety Receptacle	SG-62H Gray for Normal and SG-62H Red for Emergency
9.	Emergency Duplex Receptacle 20 Amp, 125 Volt	8300 Red
10.	Isolated Ground Receptacles 20A-125 Volt, Ground Wire shall be routed back to main switchboard ground or separately derived system ground in accordance with NEC requirements.	IG6300 with Orange Cover Plate

B. Receptacles on emergency power shall be red in color. Coverplates for emergency outlets in these areas shall be engraved with panel and circuit no. designation per NEC. Engraving shall be 1/8" high, block style letters, with red filler on front side of coverplates.

2.4 PLATES

A. Furnish and install wall plates for all wiring devices. Plates for flush devices shall be Pass and Seymour "RP" Series high impact thermoplastic, and shall be gray in color. Oversize plates are not

acceptable. Weatherproof switch plates shall be Crouse Hinds DS185 type. Where switches and/or receptacles are shown adjacent to each other, provide a common cover plate for each group of devices.

B. Furnish and install wall plates for all wiring devices. Plates shall be Pass and Seymour Type 302 stainless steel. Oversize plates are not acceptable. Weatherproof switch plates shall be Crouse Hinds DS185 type. Where switches and or receptacles are shown adjacent to each other, provide common plate for each group of devices.

2.5 MULTI-OUTLET SURFACE ASSEMBLIES

A. Provide two piece surface metal raceway assemblies manufactured by the Wiremold Company or Walker Parkersburg Products, complete including fittings, devices, end closures, conduit entrance fittings, elbows, and boxes. Except where specified otherwise on the drawings, provide Wiremold G-4000 Series base cover and divider and provide accessory devices as noted on the drawings.

2.6 FLOOR OUTLETS

A. Flush Mounted Floor Boxes and Floor Outlets: Provide Steel City No. 664 box, No. 664-CST cover, one 20A, 125V duplex receptacle, one 664RP receptacle faceplate, and one 664BP blank faceplate for each flush mounted floor convenience outlet. When carpet is indicated on the finish schedule, supply each floor box or outlet with an appropriate carpet flange.

B. Poke-Thru Service Fittings: Provide Steel City poke-thru service fittings or approved equal complete with a FPT-400 series fire rated insert suitable for the distribution of power, communications, and data wiring. Provide FPT-400 series service fitting heads with faceplate types as noted on the drawings, or as required to meet specified project needs.

2.7 UNDERFLOOR DUCT AND FITTINGS

A. This Contractor shall furnish and install an underfloor duct system as shown on the plans, complete with all junction boxes, end caps, elbows, conduit adapters, supports, anchors, covers, flanges and other necessary components for a complete and workable installation.

B. The system shall consist of No. 2 power duct and No. 4 communications duct with inserts 24" on center. Duct shall be manufactured by Walker/Parkersburg, Cellco or approved equal.

C. Power duct and comm./computer duct shall be aligned with 1-inch spacing between parallel duct runs using duct supports spaced at 5 foot intervals and as recommended by the manufacturer. Top of inserts shall be made watertight with sealing compound.

D. Provide service fittings where shown on the plans. Prior to installation verify service fitting locations with the Owner.

E. Devices and cover plates shall be similar to those specified for floor outlets.

2.8 Where devices are installed on exposed fittings or boxes, the plates shall be galvanized and of a type designed to fit the box. Blank covers shall be installed on all boxes without devices or fixtures, of same type as installed on devices in the room or area.

2.9 Test wiring devices to ensure electrical continuity of grounding connections and proper polarity.

3. EXECUTION

3.1 INSTALLATION

A. Install wiring devices as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices and other work.

C. Testing: Test wiring devices for electrical continuity and proper polarity of connections. Test wiring devices to demonstrate compliance with requirements.

D. All outlets shall be located as shown on the drawings, except that where practicable, outlets shall be located in center of panels or trim or otherwise symmetrically located to conform with existing structural layout. Outlets incorrectly installed shall be corrected. Damaged items or damaged finishes shall be repaired or replaced at no expense to the Owner.

E. Outlets shall be set plumb or horizontal and shall extend to the finished surface of the walls, ceiling or floor, as the case may be, without projecting beyond the same.

F. Receptacles, switches, etc., shown on wood trim, cases or other fixtures shall be installed symmetrically; and, where necessary, shall be set with the long dimensions of the plate horizontal, or ganged in tandem.

G. Where dimmer switches are shown adjacent to standard switches, both shall be installed in separate back boxes with adequate space between so that neither cover plate requires cutting.

H. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.

I. Where devices are shown mounted adjacent to one another on the drawings, provide multi-gang faceplates to cover all devices.

END OF SECTION 262726

SECTION 26 51 00 – LIGHTING

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections apply to the work of this Section.

B. Division 26 "Basic Materials and Methods" sections apply to the work in this Section.

1.2 DESCRIPTION OF WORK

A. Types of interior and exterior lighting fixtures in this Section include the following:

1. High Intensity Discharge

a. Metal-Halide
b. High-Pressure-Sodium

2. Fluorescent
3. Incandescent
4. LED

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacturer of interior and exterior light fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than three years.

B. Installer: Qualified with at least three years of successful installation experience on projects with interior and exterior lighting fixture work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with the NEC as applicable to the installation and construction of lighting fixtures.

B. NEMA Compliance: Comply with applicable requirements of NEMA Standard Pub. Nos. LE-1 and LE-2 pertaining to lighting equipment.

C. ANSI/UL Compliance: Comply with ANSI/UL Standards pertaining to interior and exterior lighting fixtures for hazardous locations.

D. UL Compliance: Provide light fixtures that have been UL listed and labeled.

E. CBM Labels: Provide fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association Standards and carry the CBM label.

F. NECA Compliance: Comply with NECA's "Standard of Installation".

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data on lighting fixtures.

B. SHOP DRAWINGS

1. Furnish shop drawing portfolios (collated bound sets) containing the following information:

    a. Name of manufacturer
    b. Descriptive cut sheets
    c. Complete photometric information
    d. Coefficient of utilization tables
    e. Fixture voltage
    f. The number, type and wattage of the fixture lamps
    g. Lens types
    h. Fixture options
    i. Fixture mounting details
    j. Fixture door types
    k. Construction of fixture housing and/or door
    l. Fixture ballast manufacturer and type

2. All lighting fixtures required to be used on this project shall be submitted in one single submittal so that all fixtures can be reviewed at one time. Those fixtures not receiving a shop drawing action of "Reviewed" or "Reviewed and Noted" on the first submittal shall be resubmitted for review. A light fixture receiving a shop drawing action of "Resubmit" or "Rejected" after the third review for any reason, shall be furnished as originally specified.
3. The portfolios shall be made from standard manufacturer's specification sheets. Each fixture shall be identified by the letter or number indicated on the fixture schedule. The combining of more than one fixture type of fixture on a single sheet shall not be acceptable.

1.6 EXTRA MATERIALS

A. At substantial completion of the project, furnish the following extra materials that match specified and installed products to the Owner for future use after completion of project warranty periods. Extra materials shall be delivered and stored at a location or locations directed by the Owner. Products shall be packaged with protective covering for storage and shall be suitably labeled by product type.

1. Provide ten extra lamps for every 100 lamps (of each rating and type) installed on the project. Provide a minimum of at least one extra lamp for each lamp type and rating used.
2. Provide one extra lens and one extra louver for every 100 units (of each type) installed on the project. Provide a minimum of at least one extra lens and one extra louver for each type used.
3. Provide one extra ballast for every 100 units (of each type) installed on the project. Provide a minimum of at least one extra ballast for each type used.

2. PRODUCTS

2.1 MANUFACTURER: Manufacturers of lighting fixtures are noted on the drawings by notes and/or by the light fixture schedule.

2.2 SUBSTITUTIONS: If the Contractor proposes to substitute lighting fixtures for those shown on the drawings or specified herein, he shall submit a list of proposed fixtures together with technical data to substantiate that the substitute fixtures are equivalent in all respects to the specified equipment. Proposed substitute fixtures must be submitted to the architect/engineer for review a minimum of ten (10) days prior to the project bid date. Only original documentation will be accepted for review. Copies sent via facsimile or e-mail will not be accepted. After review of the proposed substitute fixtures, an addendum or bid bulletin will be issued to include acceptable equipment. The review of substitute equipment in no way relieves the contractor of the responsibility to provide equipment that is equivalent in all respects to specified fixtures. Lighting fixtures as shown on the drawings or specified herein shall be used as a basis and standard of comparison in the review and consideration of fixtures of other manufacturers. The Architect/Engineer shall have the final

authority as to whether the fixture is equivalent to the specified item. The proposed substitution may be rejected for the aesthetic value if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

2.3 FLUORESCENT BALLASTS

A. Ballasts for fluorescent lamps shall be of the high frequency electronic type, operating lamps at a frequency of 20 kHz or higher with no detectable flicker. Ballasts for fluorescent lamps shall be manufactured by Osram Sylvania, Advance, Universal Lighting Technologies or General Electric unless otherwise noted or specified herein. The warranty period for fluorescent ballasts shall be five years from the date of substantial completion of the project, including all parts and labor. Ballasts shall be specifically designed for the type and quantity of lamps indicated on the drawings, and shall be designed to provide full light output (except for emergency fluorescent power packs). All fluorescent ballasts shall be UL listed and CSA certified. Ballasts shall have an audible noise rating of Class 'A'.

B. Ballasts for T2, T4, or T5 lamps shall contain dynamic end of lamp life sensing circuiting to protect against overheated bases and sockets.

C. Universal input voltage (120-277 VAC) ballasts shall be provided for T8 instant start, T8 programmed rapid start and T4 compact fluorescent applications. All other ballasts shall have a nominal line voltage of 120 or 277 VAC as indicated on the drawings or as required for proper system operation.

D. Ballasts shall have an input current total harmonic distortion content of less than 10 percent (based on the full light output current level). The lamp current crest factor for any ballast shall not exceed 1.7. Ballasts shall have a power factor of 98 percent or greater, and shall contain no PCB's.

E. Ballasts shall comply with all applicable State, Federal and industry performance and safety standards. Ballasts shall comply with FCC requirements governing electromagnetic and radio frequency interference. Ballasts shall comply with IEEE standards for line voltage transient protection, and shall meet or exceed ANSI and IEEE standards for harmonic distortion. Ballasts shall have internal electronic protection to prevent catastrophic failures.

F. For T8 lamp applications, provide instant start ballasts (equivalent to Osram Sylvania Quicktronic Professional Series) to operate lamps in parallel so that if one lamp fails, other lamps will remain operational.

G. For T8 lamp applications, provide programmed rapid start ballasts (equivalent to Universal Lighting Technologies AccuStart Series) to properly heat lamp filaments and minimize glow current during the starting process.

H. For T5 and T5HO lamp applications, provide programmed rapid start ballasts equivalent to Osram Sylvania Quicktronic Prostart Professional Series.

I. For TT5 lamp applications, provide programmed rapid start ballasts equivalent to Osram Sylvania Quicktronic Prostart Professional Series.

J. For T4 compact fluorescent lamp applications, provide programmed rapid start ballasts equivalent to Osram Sylvania Quicktronic CF – Universal Professional Series (universal voltage 120 – 277 VAC and multi lamp compatibility).

K. Ballasts for Dimming: Provide a fluorescent dimming system consisting of electronic dimming ballasts (equivalent to Lutron Hi-Lume Series) and controls made by the same manufacturer. Ballasts and controls shall be produced by the same manufacturer who shall have a minimum of ten-(10) years experience with electronic dimming ballasts. Dimming shall be smooth and

continuous without flicker down to one percent light output. Ballasts shall be capable of striking lamps at any light level without first flashing to full light. Different lamp lengths of the same type shall dim evenly when controlled by the same dimmer. One- and two-lamp ballasts shall dim evenly when controlled by the same dimmer. Ballasts shall be inaudible in a 27dB room ambient throughout the dimming range. Ballasts must comply with FCC Part 18 regulations and shall not interfere with other properly installed electrical equipment. Ballasts shall be UL listed, Class P and shall meet ANSI C62.41 (IEEE Publication 587, Category A) standards for surge protection.

L. Emergency Fluorescent Power Packs: Where indicated on the drawings, provide fluorescent fixtures equipped with Bodine (or equivalent) REDiTEST® B50ST self-testing fluorescent emergency ballasts. Electronic circuitry shall be self-testing in design and shall automatically test emergency lighting for a minimum of 30 seconds every 30 days, and 90 minutes once per year. An embedded micro-controller shall continually monitor the battery charging current and voltage. An audible alarm and light-emitting diode shall be provided to indicate test results and status conditions. The B50ST shall consist of a high-temperature, maintenance-free nickel-cadmium battery, charger and electronic circuitry contained in one 13 3/8" x 2 3/8" x 1 1/2" red metal case. A solid-state light shall be provided to indicate the status of the charger, the battery and potential fault conditions. A single-pole test switch and all necessary installation hardware shall be provided with each unit. The emergency ballast shall be capable of operating one or two fluorescent lamps (of the type indicated on the lighting fixture schedule) at 1100 lumens (minimum) initial light output in the emergency mode for a minimum of 90 minutes. The B50ST shall require 4.0 Watts of input power, shall have a 24.0 Watt-hour battery capacity, and shall exceed emergency standards set forth by the current NEC. The emergency ballast shall be UL Listed and CSA Certified for installation inside, on top of, or remote from the fixture and shall be warranted for a full five years from the date of substantial completion of the project.

2.4 HIGH INTENSITY DISCHARGE BALLASTS

A. Ballasts for HID lamps shall be manufactured by Venture Lighting, Universal Lighting Technologies, Osram Sylvania or Advance.

B. Provide multi-tap, single lamp, protected, high power factor CWA type ballasts for high intensity discharge lamps, unless indicated or specified otherwise. Ballasts shall be designed and constructed in accordance with all applicable ANSI specifications and requirements. Ballasts shall be designed with class “H” (180 degrees C) or higher insulation systems and shall be vacuum impregnated with a 100% solid based resin. Ballasts shall be designed to provide reliable lamp starting down to minus 40 degrees C for high-pressure sodium applications and minus 30 degrees C for standard metal halide applications. Ballasts shall be suitable for 150 degrees F interior applications. Ballasts shall be designed and constructed to operate for at least 180 cycles of 12 hours on and 12 hours off, with the lamp circuit in an open or short-circuited condition and without undue reduction in ballast life. Ballast capacitors shall be provided with a self-contained internal bleeder resistor. Oil-filled capacitors shall be housed in corrosion resistant steel cans and shall contain quick disconnect terminals. Ignitors shall be epoxy-filled with either a plastic or aluminum external housing. Ignitors shall be designed and constructed to provide six months of lamp open circuit operation without failure. Provide lamp and ballast combinations that are designed and constructed to ensure compatibility and proper system operation.

C. **INSERT PULSE START METAL HALIDE BALLAST SPEC HERE**

D. All ballasts shall be guaranteed for a minimum of twelve months from date of acceptance and during this period, shall be replaced, upon failure, at no cost to the Owner.

2.5 LAMPS

A. All fluorescent, H.I.D., and incandescent lamps shall be manufactured by Osram/Sylvania, Philips, General Electric or Venture. Lamps of other manufacturers may be installed only after written

approval is obtained from the Architect/Engineer. Failure to obtain written approval will result in the rejection of all installed lamps, and will require the installation of the lamps specified herein, at no expense to the Owner.

PART 2 - NOTE TO SPECIFIER: DOCUMENT SPECIFIC INCANDESCENT LAMP REQUIREMENTS ON THE DRAWINGS (I.E. LAMP TYPE, LAMP DISTRIBUTION, WATTAGE, ETC.). CONSIDER TUNGSTEN HALOGEN ALTERNATES

B. Incandescent lamps shall be rated at 130 volts and of the size and type as shown on the drawings.

C. Provide T8 fluorescent lamps that have full rated life when operating on Instant Start, Rapid Start or Programmed Rapid Start electronic ballasts. Provide lamps with a minimum average rated life of 20,000 hours, a minimum color rendering index of 85, minimum initial lumen output of 2150 (for F25T8 lamps) and a correlated color temperature of 4,100 degrees Kelvin, or as noted on the drawings. Provide low mercury type lamps that are designed and manufactured to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) criteria for classification as non-hazardous waste.

D. Provide T5 and T5HO fluorescent lamps with a minimum average rated life of 20,000 hours, a minimum color rendering index of 82, minimum initial lumen output of 2,900 (for F28T5 lamps), minimum initial lumen output of 5,000 (for F54T5HO lamps), and a correlated color temperature of 4,100 degrees Kelvin, or as noted on the drawings.

E. Provide 4-pin, T4, triple tube compact fluorescent lamps with a minimum efficacy of 75 lumens per watt, a minimum average rated life of 10,000 hours, a minimum color rendering index of 82, and a correlated color temperature of 4,100 degrees Kelvin, or as noted on the drawings. Provide low mercury type lamps that are designed and manufactured to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) criteria for classification as non-hazardous waste.

F. Provide 4-pin, T4, quad tube compact fluorescent lamps with a minimum average rated life of 10,000 hours, a minimum color rendering index of 82, and a correlated color temperature of 4,100 degrees Kelvin, or as noted on the drawings. Provide low mercury type lamps that are designed and manufactured to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) criteria for classification as non-hazardous waste.

G. Provide 4-pin, TT5, long compact fluorescent lamps that have full rated life when operating on Instant Start or Rapid Start electronic ballasts. Provide lamps with a minimum average rated life of 20,000 hours, a minimum color rendering index of 82, minimum initial lumen output of 3150 (for FT40 lamps) and a correlated color temperature of 4,100 degrees Kelvin, or as noted on the drawings.

I. Provide ceramic, metal halide PAR lamps with a minimum average rated life of 9,000 hours, plus or minus 200 degrees Kelvin (maximum) color stability over the lifetime of the lamp, a minimum color rendering index of 81 (for 3000 degree Kelvin lamps), a minimum color rendering index of 92 (for 4,000 degree Kelvin lamps), and suitable for use in open or enclosed fixtures. Provide low mercury type lamps that are designed and manufactured to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) criteria for classification as non-hazardous waste.

K. Provide ED-17, universal operating position, ceramic metal halide lamps with a minimum average rated life of 9,000 hours, plus or minus 200 degrees Kelvin (maximum) color stability over the lifetime of the lamp, a minimum color rendering index of 82 (for 3000 degree Kelvin lamps), a minimum color rendering index of 90 (for 4,000 degree Kelvin lamps), and suitable for use in open or enclosed fixtures. Provide low mercury type lamps that are designed and manufactured to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) criteria for classification as non-hazardous waste.

L. **INSERT STANDARD METAL HALIDE LAMP SPEC HERE**

M. **INSERT PULSE START METAL HALIDE LAMP SPEC HERE**

1. All lamps shall be new and shall be delivered to the project in manufacturer's original sealed package. At the time of acceptance of this project by the Owner, all lamps shall be in working order, and all fixtures shall be fully lamped.
2. Fluorescent and H.I.D. lamps shall be guaranteed for a minimum of twelve months from the date of project substantial completion and during this period shall be replaced, upon failure, at no cost to the Owner.
3. Incandescent lamps shall be guaranteed for 30 days from the date of project substantial completion and during this period, shall be replaced, upon failure, at no cost to the Owner.

2.6 FLUORESCENT FIXTURE LENSES

A. Plastics: Where the fixtures specified require the use of acrylic plastic lenses, materials of the highest quality conforming to the following requirements must be supplied.

1. Use 100 percent virgin acrylic thermoplastic.
2. All raw material used shall meet ASTM D 788, Grade 8, and shall exceed IES-SPI-NEMA specifications by at least 100 percent.
3. Lens thickness shall not be less than 0.125 inches over all. Penetrations shall not exceed 0.08 inches.

2.7 PLASTER FRAMES

A. Standard plaster frames shall be provided for all recessed lighting fixtures installed in plaster or drywall finished walls or ceilings. Coordinate with architectural drawings.

2.8 THERMAL PROTECTION

A. All recessed incandescent and H.I.D. light fixtures shall be provided with thermal protection per N.E.C requirements.

3. EXECUTION

3.1 INSTALLATION

A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Coordinate with other electrical work as appropriate to properly interface installation of lighting fixtures with other work.

C. Adjust and Clean: Clean lighting fixtures of dirt and debris upon completion of the installation. Protect installed fixtures from damage during the remainder of the construction period.

D. Field Quality Control: Upon completion of the installation of lighting fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

E. Undercabinet and undercounter light fixtures shall be installed with 3/8" deep x 2" x 4" wood spacers painted black to provide an air space between the fixture and the top of the millwork.

F. The lighting design for this project has included multi-level lighting in some rooms. Where 3 lamps fixtures are shown in a room, the outer 2 lamps will be switched from one switch and the center lamp will be switched from the other switch. Where 4 lamp fixtures are shown in a room, the outer 2 lamps will be switched from one switch and the center 2 lamps will be switched from the other switch. A similar multi-level lighting arrangement will be provided where 4-3 way switches are shown. Two ballasts must be used when dual level switching is shown.

G. Surface Mounted Fluorescent Fixtures: Where fixtures are indicated for installation on low-density cellulose fiberboard (see room finish schedule on drawings), provide 1-1/2 inch ceiling spacers, unless UL approved for mounting directly to the ceiling material.

H. Lighting fixture supports: Properly support and install fixtures in strict accordance with all applicable building codes and standards. Fully and completely coordinate the installation of fixtures with actual ceiling systems, and with all building trades. In general, provide fixture supports according to the following (unless applicable codes require more restrictive support details):

I. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide two (2) No. 12 gage hangers from each fixture housing to the building structure above (wires may be installed slack). Light fixtures that weigh more than 56 pounds shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system.

J. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging.

K. Adjust all incandescent fixture sockets to match the lamp specified and aim all adjustable fixtures as directed by the Architect/Engineer.

L. Square and rectangular fixtures shall be mounted with sides parallel to building and ceiling lines, unless otherwise noted.

M. Where special fixtures to be used in special ceilings are scheduled, verify all ceiling system details and coordinate fixture type and accessories prior to ordering fixtures. Coordinate and cooperate with ceiling system supplier in the preparation of ceiling system shop drawings.

N. Install fluorescent fixtures as recommended by the manufacturer, or as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection, or angular jointing of fixtures suspended in continuous rows.

O. Provide concrete bases for pole mounted fixtures as detailed on the drawings and as specified herein.

P. Concrete shall be 3000 psi, minimum.

Q. Provide anchor bolts of the size and orientation recommended by the manufacturer. The recommendations of the manufacturer shall govern the installation of all anchor bolts irrespective of any conflicting information.

R. Where conductors are strung within poles, take all steps necessary to insure that the conductor insulation will not wear by virtue of pole movement caused by wind or similar action. Consult the pole manufacturer for recommendations.

S. Grounding of Pole Mounted Fixtures: Connect the green ground wire specified in Section 260526, "Grounding System", to the pole ground and luminaire ground.

END OF SECTION 265100