

Project Manual

Dr. Tashman Dry Lab
Issue for Bid and Construction
10 March 2017
PWP Project No. 216-042

OWNER

UT-Health
6431 Fannin Street
Houston, TX 77030
(713) 500-3915

ARCHITECT

Philo Wilke Partnership
11275 S. Sam Houston Parkway W.
Suite 200
Houston, Texas 77031
(832) 554-1130

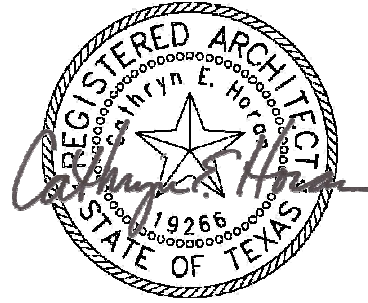
MEP ENGINEER

E&C Engineers & Consultants, Inc.
1010 Lamar St, Suite 650
Houston, Texas 77002
(713) 580-8820

**SECTION 00 01 07
SEALS PAGE**

ARCHITECT

Ms. Cathryn E. Horan
PhiloWilke Partnership
11275 S. Sam Houston Pkwy W
Suite 200
Houston, TX 77031
P: (832) 554-1130
E: choran@pwarch.com



MEP ENGINEER

Mr. William C. Clifford
E&C Engineers & Consultants, Inc.
1010 Lamar St. Suite 650
Houston, Texas 77002
Firm ID No.: F-003068
P: (713) 580-8820
E: Clifford@eceng.com



END OF SECTION

SECTION 00 01 10
TABLE OF CONTENTS

PROCUREMENT AND CONTRACTING REQUIREMENTS

1.01 DIVISION 00 -- PROCUREMENT AND CONTRACTING REQUIREMENTS

- A. 00 01 07 - Seals Page
- B. 00 01 10 - Table of Contents

SPECIFICATIONS

2.01 DIVISION 01 -- GENERAL REQUIREMENTS

- A. 01 10 00 - Summary
- B. 01 30 00 - Administrative Requirements
- C. 01 35 53 - Security Procedures
- D. 01 42 19 - Reference Standards
- E. 01 57 21 - Indoor Air Quality Controls
- F. 01 60 00 - Product Requirements
- G. 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions
- H. 01 70 00 - Execution and Closeout Requirements
- I. 01 78 00 - Closeout Submittals

2.02 DIVISION 02 -- EXISTING CONDITIONS

- A. 02 41 00 - Demolition

2.03 DIVISION 03 -- CONCRETE

2.04 DIVISION 04 -- MASONRY

2.05 DIVISION 05 -- METALS

2.06 DIVISION 06 -- WOOD, PLASTICS, AND COMPOSITES

- A. 06 10 00 - Rough Carpentry
- B. 06 41 00 - Architectural Wood Casework

2.07 DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

- A. 07 84 00 - Firestopping
- B. 07 92 00 - Joint Sealants

2.08 DIVISION 08 -- OPENINGS

- A. 08 11 13 - Hollow Metal Doors and Frames
- B. 08 14 16 - Flush Wood Doors
- C. 08 71 00 - Door Hardware
- D. 08 80 00 - Glazing

2.09 DIVISION 09 -- FINISHES

- A. 09 21 16 - Gypsum Board Assemblies
- B. 09 51 00 - Acoustical Ceilings
- C. 09 65 00 - Resilient Flooring
- D. 09 91 23 - Interior Painting

2.10 DIVISION 10 -- SPECIALTIES

2.11 DIVISION 11 -- EQUIPMENT

2.12 DIVISION 12 -- FURNISHINGS

- A. 12 36 00 - Countertops

2.13 DIVISION 13 -- SPECIAL CONSTRUCTION

- A. 13 49 05 - X-Ray Radiation Protection

2.14 DIVISION 14 -- CONVEYING EQUIPMENT

2.15 DIVISION 21 -- FIRE SUPPRESSION

- A. 21 12 00 - Fire Protection Systems
- B. 21 13 13 - Wet-Pipe Fire Sprinkler System

2.16 DIVISION 22 -- PLUMBING

- A. 22 10 00 - Plumbing Piping and Accessories
- B. 12 36 00 - Plumbing Piping Valves and Accessories

2.17 DIVISION 23 -- HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

- A. 23 00 01 - Mechanical General Provisions
- B. 23 00 10 - Mechanical Scope of Work
- C. 23 03 00 - Basic Materials and Methods
- D. 23 05 93 - Testing Adjustments and Balancing
- E. 23 05 94 - Testing and Balancing
- F. 23 07 00 - System Insulation
- G. 23 31 13 - Ductwork
- H. 23 31 14 - Ductwork Accessories
- I. 23 37 13 - Air Distribution Devices

2.18 DIVISION 26 -- ELECTRICAL

2.19 DIVISION 27 -- COMMUNICATIONS

2.20 DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY

2.21 DIVISION 31 -- EARTHWORK

2.22 DIVISION 32 -- EXTERIOR IMPROVEMENTS

2.23 DIVISION 33 -- UTILITIES

2.24 DIVISION 46 -- WATER AND WASTEWATER EQUIPMENT

END OF SECTION

SECTION 23 00 01 – MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and this Section govern the work of this Division.
- B. All work covered by this Section and Associated Division 21, 22 and 23 Sections of these Specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.2 DESCRIPTION OF WORK:

- A. General: This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, equipment, transportation, storage, utilities and all required permits and licenses. All work performed under this Section shall be in accordance with the Drawings and Specifications and subject to the terms and conditions of the Contract. For purposes of these Specifications, "provide" and "furnish and install" shall be synonymous.
- B. Work Included: This Work includes the furnishing of all labor, materials, equipment, fixtures, apparatus and appurtenances required for complete installation of operating heating, ventilating, air conditioning, plumbing and fire protection systems as specified, in place and ready for service. Refer to Section 23 00 10, "Mechanical Scope of Work" and Division 21, 22 and 23 Specification Sections for additional requirements.
- C. Drawings: Refer to the Mechanical and Plumbing Drawings for graphic representations, schedules, and notations showing mechanical and plumbing work.
- D. Specifications: Refer to Division 21, 22 and 23 for the primary technical specifications of mechanical and plumbing work.
- E. Work of Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division. The actual performance of the Work stays within the Section in which it occurs; but subject to the requirements of this Section to the extent applicable.
 - 1. Finish painting of mechanical systems in areas exposed to the view of building occupants is specified in other Divisions. All prime and protective painting for all areas and finished painting of mechanical systems in areas not exposed to the view of building occupants shall be provided under this Division.
 - 2. Installation of electrical control power which is not specified as an integral part of equipment specified under this Division is specified under Division 26 and where shown on the Electrical Drawings. Necessary conduit, wiring, boxes, and fittings are specified under Division 26.
 - 3. Access doors in finished surfaces are specified under other Divisions. Locations are as shown on the Drawings and as required for proper equipment access. Access panels

shall be located on coordination drawings provided by this contractor and based on final equipment locations and access requirements.

4. Concrete housekeeping pads and supporting structures are specified under this Division. Dimensions and locations of pads and supports shall be the responsibility of this Division. Housekeeping pads shall be located on coordination drawings provided by this contractor and based on actual equipment being furnished and final equipment locations.
 5. Owner and General Contractor-furnished equipment is furnished and installed under other Divisions. Proper HVAC and Plumbing provisions, including rough-in and final equipment connections, are included in the Work of this Division.
- F. Workmanship: All mechanical and plumbing work shall be constructed and finished in every respect in a workmanlike and substantial manner. Furnish and install all work as may be necessary to complete systems in accordance with the best trade practice and to the satisfaction of the OR and Engineer. The entire installation shall be ready in every respect for satisfactory and efficient operation when completed. The OR and Engineer will interpret the meaning of the drawings and specifications and will reject all work and materials which, in their judgment, is not in full accordance therewith.
- G. Certification: Submit a single certification stating that all portions of the work are in accordance with contract requirements. Warranty all work against faulty and improper material and workmanship for a period of one year from date of final acceptance by the OR, except that where guarantees or warranties for longer terms are specified by contract, such longer term shall apply. At no additional cost to Owner, within 24 hours after notification, correct any deficiencies which occur during the warranty period, to the satisfaction of the Owner.
- H. Safe Work Place: The Contractor covenants and agrees that he and his Subcontractors and his and their agents and employees will provide and maintain a safe place to work and will comply with all laws and regulations of any governmental authorities having jurisdiction thereof, and the contractor agrees to indemnify, defend and hold harmless, the Engineer and Owner from and against any liability, loss, damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractors and his and their agents and employees to provide and maintain a safe place to work or to comply with laws and regulations of governmental authorities having jurisdiction thereof.
- I. Indemnification: The Contractor and each Subcontractor covenants and agrees to indemnify, defend and hold harmless the Engineer and Tenant against any liability, loss, damage or expenses, including reasonable attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractor or his or their agents and employees properly to discharge the obligations assumed by him or them in the performance of the work, including any act or omission allegedly resulting in death or personal injury or property damage on improper construction, construction techniques, or the use of improper or inappropriate material or tools.
- 1.3 CODES, PERMITS AND FEES:
- A. General: Comply with the most recently revised versions of applicable laws, rules, regulations and ordinances of federal, state, and local utilities and authorities. Where alterations to and deviations from the Contract Documents are required by said authority, report the requirements and secure approval before starting work. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.

- B. Code Design Basis: The following codes and ordinances were used in the design of the project and shall be complied with during construction of the project.
- | | | |
|----|--------------------|---|
| 1. | Building Code | 2012 International Building Code. |
| 2. | Fire Code | 2012 International Fire Code. |
| 3. | Electrical Code | 2014 National Electrical Code. |
| 4. | Mechanical Code | 2012 International Mechanical Code. |
| 5. | Plumbing Code | 2012 International Plumbing Code. |
| 6. | Energy Code | 2015 International Energy Code. |
| 7. | Accessibility Code | Texas Accessibility Standards(TAS), 2012 and Americans with Disabilities Act of 1990. |
- C. Codes and Standards: All work shall be done in full compliance with all applicable state and local codes, requirements and ordinances and applicable requirements of NFPA, UL and other applicable standards.
- D. Industry Standards: All equipment and materials shall be new and listed by the Underwriters' Laboratories, inc., Manufactured in full accordance with applicable ASME, NEMA, ANSI or IEEE standards.
- E. Approvals, Permits and Inspections: Secure and pay for all necessary approvals, permits, inspections, etc., and deliver the official records of the granting of permits to the Owner without additional cost to the Owner.
- F. Precedence: Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule. Any modifications resulting therefrom shall be made without additional cost to the Owner or Engineer. This Contractor shall report any such modifications to the Engineer and secure his approval before proceeding.

1.4 QUALITY ASSURANCE AND STANDARDS:

- A. Materials/Methods: Manufacturers, materials, and methods described in the various sections of the Specifications, and indicated on the Drawings are intended to establish a standard of quality only. It is not the intention of the Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers standard product will meet the requirements of the project design, Specifications and space constraints. **The Engineer shall be the sole judge of quality and equivalence of equipment, materials and methods.**
- B. Alternative Products/Materials/Methods: Products by other reliable manufacturers, other materials and other methods may be accepted provided they have equivalent capacity, construction and performance. **Under no circumstances shall any substitution be made without the prior written approval of the Engineer.** Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Engineer that the specified product, material or method is the only one that shall be used without prior approval. Wherever a definite material or manufacturer's product is specified and the Specification states that products of

similar design and equal construction from the specified list of manufacturers may be provided, it is the intention of the Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without prior written approval.

- C. Alternative Equipment: Where substituted or alternative equipment is used on the project, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available, including all required Code and maintenance clearances, and to coordinate all equipment requirements and provisions with the Mechanical (HVAC) and Plumbing Design and all other Contractors.
- D. Standards: Refer to Division 1 for general administrative/procedural requirements related to compliance with applicable standards. This Work and all materials shall meet the standards set forth in the applicable portions of the following recognized standards:
1. ADC Air Diffusion Council.
 2. AGA American Gas Association.
 3. AMCA American Movement and Control Association.
 4. ANSI American National Standards Institute.
 5. ARI American Conditioning and Refrigeration Institute.
 6. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers.
 7. ASME American Society of Mechanical Engineers.
 8. ASPE American Society of Plumbing Engineers.
 9. ASSE American Society of Sanitary Engineering.
 10. ASTM American Society for Testing and Materials.
 11. AWS American Welding Society.
 12. AWWA American Water Works Association.
 13. CDA Copper Development Association.
 14. CISPI Cast Iron Soil Pipe Institute.
 15. ETL Electrical Testing Laboratory.
 16. FM Factory Mutual Engineering Corporation.
 17. FS Federal Specification (General Services Administration).
 18. IRI Industrial Risk Insurers.
 19. MCAA Mechanical Contractors Association of America.
 20. MSS Manufacturers Standardization Society of the Valve and Fittings Industry.
 21. NEC National Electrical Code (by NFPA).
 22. NEMA National Electrical Manufacturers Association.
 23. NFPA National Fire Protection Association.
 24. OSHA Occupational Safety Health Administration (US Department of Labor).
 25. PDI Plumbing and Drainage Institute.

- 26. SMACNA Sheet Metal & Air Conditioning Contractors' National Association.
- 27. UL Underwriters' Laboratories, Inc.

1.5 SITE VISIT AND FAMILIARIZATION:

- A. General: Become familiar with the Drawings and Specifications, examine the premises, and understand the conditions under which the Contract shall be performed, prior to submitting a bid.
- B. Site: Be informed of the site conditions, verify locations of new and existing equipment, and determine exact requirements for connections.
- C. Coordination: Submission of a bid for this project infers that the Contractor has visited the site and has become familiar with the Drawings and site conditions and has included in his proposal, all work necessary to properly install the systems on the project.
- D. Pre-Bid Conference: Refer to Division 1.

1.6 DRAWINGS AND SPECIFICATIONS:

- A. General: The Drawings are schematic in nature and indicate approximate locations of the heating, ventilating and air conditioning systems, plumbing equipment, fixtures and piping systems, except where specific locations are noted and dimensioned on the Drawings. All items are shown approximately to scale. The intent is to show how these items shall be integrated into the construction. Locate all items by on the job measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.
- B. Location: Prior to locating diffusers, grilles, other exposed air devices, plumbing fixtures, fire hose cabinets, and plumbing items, obtain the Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Mount plumbing fixtures, fire hose racks, and cabinets at the heights directed by the Engineer. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.
- C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specifications are competent to fully explain, may not be mentioned on the Drawings.
- D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made in writing to the Engineer.

1.7 DISCREPANCIES:

- A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof. All questions and requests for clarifications shall be submitted in writing to the Engineer.
- B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall apply to the Engineer for such further Drawings or explanations as may be necessary, allowing a reasonable time for the Engineer to respond.

The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.

- C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. No alleged statement by the Engineer will be accepted as an excuse for inferior work.
- D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required by the nature of the project.
- E. Discrepancy Notification: Immediately notify engineer in writing when existing field conditions differ from the conditions shown on the contract documents.

1.8 SAFETY REGULATIONS:

- A. General: All electrical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the mechanical work shall be provided by and operated by the Mechanical contractor.
- B. OSHA: It shall be the duty and responsibility of the Contractor and all of its subcontractors to be familiar and comply with all requirements of Public Law 91596, 29 U.S.C. Secs. 651 et seq., the Occupational Safety and Health Act of 1970, (OSHA) and all amendments thereto, and to enforce and comply with all of the provisions of this Act.
- C. Emergencies: In any emergency affecting the safety of persons or property, the Contractor shall act, at its direction, to prevent threatened damage, injury or loss.

1.9 UTILITIES:

- A. General: Utility information shown on the Drawings has been shown based upon data obtained from the site survey and the agencies having jurisdiction and are accurate to the best of the knowledge of the Engineer.
- B. Coordination: The Contractor shall be responsible for field verification of the actual location of site and/or building utilities and shall make modifications necessary for connection to or construction around those utilities at no additional cost to the Owner or Engineer.

1.10 CHANGE ORDERS:

- A. General: Refer to Uniform General Conditions and Division 1 for requirement concerning Change Orders.

1.11 ALTERNATES:

- A. General: Refer to Division 1 for information concerning Alternates.

1.12 PRECONSTRUCTION CONFERENCE:

- A. Conference: Upon the award of this Contract and prior to commencing any work, the Contractor and his designated major subcontractors, shall confer with the Architect, Engineer and Owner concerning the Work under this Contract. The conference shall be at a mutually agreeable place and time.

1.13 SITE OBSERVATION:

- A. General: Observation at the site to verify general compliance with Contract Documents will be made periodically by the Engineer or his representative. Written observation comments will be submitted to the General Contractor for review and a written response.

1.14 REQUESTS FOR INFORMATION (RFI):

- A. General: All Contractor Requests for Information (RFI's) shall be submitted to the Engineer in writing, for response.
- B. Format: All RFI's shall be submitted on a form which includes the date, a sequential RFI number, the requested information and space for the Engineer's response, signature and date. RFI's shall be submitted to the Engineer in a electronic format (unprotected pdf, doc/docx or xls/xlsx format) for response.
- C. Responses: The Engineer will endeavor to provide RFI response time in the Engineer's office of five working days after receipt of the RFI by the Engineer.

1.15 SUBMITTALS:

- A. General: Submittals required for this project shall include, but not be limited to:
1. Shop Drawings and Product Brochure Submittals.
 2. Certifications and Test Reports.
 3. Operating and Maintenance Manuals.
 4. Warranties (Guarantees).
- B. Additional Requirements: Refer to Division 1 for additional submittal requirements.
- C. Shop Drawings and Product Brochure Submittals: The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment or actual Shop Drawings.
- D. Shop Drawings and Product Brochure Submittals: The Contractor shall submit one electronic (unprotected pdf format) copy or a sufficient number of complete bound hardcopy sets of Shop Drawings and complete data covering each item of equipment or material. The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment, or actual Shop Drawings. The first submittal of each item requiring a submittal must be received by the Engineer within 90 days of contract award. The Engineer shall not be responsible for any delays or costs incurred due to excessive Shop Drawing review time where the first submittal is received more than 90 days after contract award. The Architect and Engineer will each retain one copy of all hardcopy Shop Drawing submittals for their files. The Contractor is required to include a copy of all final electrical Shop Drawing submittals in Electrical O&M manuals.
1. Cover Sheet: The cover sheet shall include the Project Name and the names and addresses of the Owner, Project, Architect, M/E/P Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the Specification section number applicable to the item or items submitted, the item nomenclature and description and the submittal number. HVAC, plumbing and fire protection submittals shall be numbered sequentially by Specification section with a sequence suffix (e.g. 23 31 13-1, 23 31 13-2, 23 31 14-1, etc.). Resubmittals shall be numbered with the original

submittal number plus an R in the sequence suffix (e.g. the resubmittals of submittal 23 31 13-1 would be 23 31 13-1R1, 23 31 13-1R2, ...).

2. Index: The index page shall include a listing of all data included in the submittal.
3. List of Variations: This page shall list all variations, including unfurnished or additional items or features between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "No Variations". Where variations affect the work of other contractors, then the contractor shall certify on this page that these variations have been fully coordinated with the affected contractors and that all additional costs to the affected contractors associated with the variations shall be paid by the submitting contractor.
4. Specification Review. A copy of the appropriate specification section shall be included in the submittal with each specification paragraph marked in the right margin with a "C" for Submitted Product/Material/Installation Complies or an "N" for Submitted Product/Material/Installation Not In Compliance. All paragraphs marked with a "N" shall be specifically addressed in the Submittal List of Variations.
5. Equipment Information: Submittal shall include equipment information including manufacturer's name and designation, size, performance and capacity data. All applicable listings, labels, approvals and standards shall be clearly indicated.
6. Dimensional Data: Submittal shall include dimensional data and actual sketches as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances.
7. Identification Information: Submittal shall include Identification/designation for each item of material or equipment matching that indicated in the Specifications or on the Drawings.
8. Product Data: Submittal shall include sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method. Any non-applicable information shall be crossed out.
9. Contractor Certification: Submittal shall include certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Contract Documents, signed and dated.
10. Manufacturer Certification: Where specified, submittals shall include reports or information requiring certification which shall be certified by an authorized officer of the manufacturer or testing agency.
11. Certified Shop Drawings: Submittals shall include Certified Shop Drawings showing dimensions, loading details, anchor bolt locations and inserts required for each piece of equipment set on concrete in sufficient time to cause no delay in the Work.
12. Equipment/Material Data: Equipment and material submittals shall show sufficient data including all performance curves, sound data, recommended installation details, and sufficient data to indicate complete compliance with the Contract Documents, including proper sizes, clearances, capacities, materials, and finishes.
13. Additional Information: Submittal shall include additional information as required in other sections of this Division.

- E. Required Shop Drawing Submittals: Submit Shop Drawings, including, but not limited to the following items:
1. Fire Protection Systems Refer to Section 21 12 00.
 2. Wet-Pipe Fire Sprinkler System Refer to Section 21 13 13.
 3. Plumbing Piping and Accessories Refer to Section 22 10 00.
 4. Plumbing Valves and Accessories Refer to Section 22 10 10.
 5. Basic Materials and Methods Refer to Section 23 03 00.
 6. Motors and Controllers Refer to Section 23 04 00.
 7. Vibration Isolation Refer to Section 23 05 48.
 8. Testing, Adjustment and Balancing Refer to Section 23 05 93.
 - a. Before starting the actual Test and Balance procedure submit:
Personnel qualifications.
Equipment to be used on the project.
Testing and Balancing Forms.
 9. System Insulation Refer to Section 23 07 00.
 10. Ductwork Refer to Section 23 31 13.
 11. Ductwork Accessories Refer to Section 23 31 14.
 12. Air Distribution Devices Refer to Section 23 37 13.
 13. Coordination Drawings Refer to Section 23 00 01.
- F. Samples: Submit two samples, upon request, of mechanical/plumbing devices and materials for review by the Architect/Engineer. Samples will be returned upon written request of the Contractor.
- G. Fabrication Drawings: Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer. Submit Fabrication Drawings whenever:
1. Equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space.
 2. Where tight spaces require extreme coordination between ductwork, piping, conduit and other equipment.
 3. Where called for elsewhere in these Specifications.
 4. Where specifically requested by the Architect/Engineer.
- H. Equipment List: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment which will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the Specifications.
1. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed.
 2. This initial list shall include the proposed submittal schedule to allow the design team to schedule the required time for reviews.

3. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval.
 4. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these Specifications have been met and samples shall be furnished when requested. All manufacturer's data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.
- I. Shop Drawing Submittal Review: Shop Drawings will be reviewed for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown in review comments is subject to the requirements of the Contract Documents. The submitting Contractor is responsible for: dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades; and the satisfactory performance of his work.
1. The Engineer will endeavor to provide Shop Drawing review time in the Engineer's office of 2 weeks per review, exclusive of transmittal time, and this review time shall be considered by the Contractor when scheduling his work on the project. Submittals received outside the scheduled delivery dates may require additional time for review.
 2. The Architect's review or approval and the Engineer's review of Shop Drawings shall not relieve the Contractor of the responsibility for errors, omissions or deviations that may be contained in the submittals. If the Contractor proceeds on the basis of undetected errors, omissions or deviations in reviewed Shop Drawings, it shall be at his sole responsibility and the review does not allow deviations from the requirements of the Contract Documents. Noting some errors, omissions, and deviations but overlooking other errors, omissions, and deviations does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawing or the Engineer's review thereof, the Contract Documents shall govern the Work and are neither waived or superseded by the Shop Drawing review.
 3. It shall be the responsibility of the submitting Contractor to check all equipment and materials for conformance with the Contract Documents and a "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" submittal at the time such equipment and materials are delivered to the job site, and to notify the Engineer of any deviations.
 4. Inadequate or incomplete Shop Drawings will not be reviewed by the Architect or the Engineer and will be returned to the Contractor marked "REVISE AND RESUBMIT" for completion and resubmittal.
 5. Shop Drawings will be marked "REVIEWED WITH NO EXCEPTIONS TAKEN", "MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE", "REVISE AND RESUBMIT", or "REJECTED" when reviewed by the Engineer. The definitions of these terms for submittal review purposes is as follows:
 - a. **REVIEWED WITH NO EXCEPTIONS TAKEN** - The Shop Drawing was reviewed and no exceptions from the general conformance with the design concept and general compliance with the information given in the Contract Documents were noted.

- b. **MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE** - The Shop Drawing was reviewed and found to have either minor deviations from the requirements of the Contract Documents or information missing from the submittal, as noted. A complete Shop Drawing resubmittal is not required, however, a written response to all review comments shall be submitted in the format used for a resubmittal.
 - c. **REVISE AND RESUBMIT** - The Shop Drawing was reviewed and major deviations from general conformance with the design concept and general compliance with the information given in the Contract Documents were observed, as noted. The Shop Drawing shall be revised to eliminate the deviations noted and resubmitted.
 - d. **REJECTED** - The Shop Drawing was reviewed and is not in general conformance with the design concept or in compliance with the information given in the Contract Documents, as noted. A revised Shop Drawing submittal for the specified equipment or materials shall be resubmitted.
6. Division 1 and General Conditions requirements concerning Shop Drawing submittal review are not applicable to this Division.
 7. Materials and equipment which are purchased or installed without an "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" Shop Drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Architect/Engineer for any reason, shall be at the expense of the Contractor.
 8. Shop Drawings shall be complete and checked prior to submission to the Engineer for review. **Where more than two reviews are required for a given Shop Drawing to reach "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE" status, the Contractor will be invoiced for additional review services at a cost of \$150.00 per hour for review of the fourth and subsequent submittals.** If the Contractor fails to pay any legitimate additional review services invoice in full within 30 days, then that invoice will be forwarded to the Architect/Owner requesting that to withhold payment of the amount invoiced from the next General Contractors request for payment, as allowed for under the General Conditions of the Contract for Construction (AIA Document A-201). Incomplete submittals will be returned to the Contractor unchecked.
- J. Certifications and Test Reports: The Engineer may, at their option, witness any or all of the on and off site acceptance and operational testing. Submit a detailed listing of certification and testing for each system indicating estimated dates for completion of system installation. This listing of certification and testing shall be submitted at least 30 days before any testing is conducted.
1. Test procedures and test result reporting forms shall be submitted for review no later than the date of the certification and testing listing submittal.
 2. Notify the Engineer in writing two weeks prior to any scheduled testing to allow time for Engineer to schedule witnessing of testing, where elected by the Engineer.
 3. Submit six copies of all certifications and test reports to the Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

4. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section 23 05 93, "Testing, Adjustment and Balancing".
- K. Operating and Maintenance Manuals: Submit two copies of Operating and Maintenance Manuals to the Engineer for approval prior to the beginning of operator training. Provide four approved Operating and Maintenance Manuals for use in operator training. Manuals shall be bound in rigid cover, 3-ring binders with spine and cover labels and shall provide operating and maintenance information for every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference. Bulletins containing information about equipment which is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 23 shall be clearly and legibly set forth in memoranda which shall, likewise, be bound with bulletins. As a minimum, the following information shall be provided as applicable:
1. Complete description of each system, item of equipment, and apparatus provided under this Division, including ratings, capacities, performances, data and curves, characteristics identifying name and number, locations, and wiring diagrams, including sources for all parts.
 2. Fully detailed parts lists, including all numbered parts and recommended spare parts, of each item of equipment and apparatus provided under this Division.
 3. Manufacturer's printed instructions describing operation, service, maintenance, and repair of each item of equipment and apparatus.
 4. Typewritten record of tests made of materials, equipment, and systems included under this Division. Such records shall state the dates the tests were conducted, name(s) of person(s) making and witnessing the tests, and citing any unusual conditions relevant to the tests. Temperature control wiring diagrams complete with instructions outlining each sequential step in the start up and shutdown of the heating/cooling system. Include precautions and instructions for servicing each item of the system.
 5. Identifying names, name tags designations and locations for all equipment.
 6. Valve tag lists with valve number, type, color coding, location and function.
 7. Equipment and motor nameplate data.
 8. Copies of all approved Shop Drawing submittals and testing and balancing reports.
 9. Fabrication drawings.
 10. Equipment and device bulletins and cutsheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable.
 11. Maintenance instructions clearly highlighted to show all required periodic maintenance and lubrication.
 12. Wiring diagrams.
 13. Operating instructions clearly highlighted to show proper operating procedures for all equipment.
 14. Exploded parts views and parts lists for all equipment and devices.
 15. Color coding charts for all painted equipment and conduit.
 16. Location and listing of all spare parts and special keys and tools furnished to the Owner.

- L. Tools: Provide and deliver to the Owner's authorized representative any special tools required for maintenance of systems, equipment, and apparatus installed under this Division prior to requesting final acceptance of the installation.

1.16 PROJECT RECORD DOCUMENTS:

- A. Site Prints: Maintain a set of clearly marked black line prints of the Contract Drawings at the job site which shall be used for recording the work details, final size, location, interrelation, and similar items of all work under this Division. This set of Drawings shall be corrected daily as the Work progresses and shall clearly indicate all changes to suit field conditions, changes made by "Field Order" or "Change Order", accurate dimensions of all buried or concealed work, precise locations of all concealed work, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall be to at least two permanent structure points.
- B. Upon completion of the work, the Contractor shall transfer all marks from the site prints to a set of reproducible record "as-built" Drawings using red pencil. The reproducible record "as-built" Drawings shall have the Engineers name and seal removed or blacked out and shall be clearly marked and signed on each sheet as follows:

CERTIFIED RECORD DRAWINGS
DATE: _____

(NAME OF GENERAL CONTRACTOR)

BY: (SIGNATURE)

(NAME OF SUBCONTRACTOR)

BY: (SIGNATURE)

- C. Approval: Prior to final acceptance of the Work of this Division, the Contractor shall submit one reproducible and two black line prints of properly certified Record Drawings to the Engineer for review and shall make changes, corrections, or additions as the Engineer may require to the Record Drawings.

1.17 COORDINATION OF MECHANICAL WORK:

- A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the mechanical work, and in its interface with other work including utilities and electrical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various ductwork and piping systems and equipment items and the sizes of the major interconnecting ducts and pipes, without showing exact details as to elevations, offsets, control lines, and installation details.
 1. Arrange mechanical work in a neat, well organized manner with services running parallel with primary lines of the building construction and with a minimum of 7' overhead clearance where possible.

2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.
3. All ducts and pipes except those in the various equipment rooms, in unfinished spaces or where specifically designated herein or on the Drawings shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in piping, equipment placement, ductwork, etc.
4. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor.
5. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed:
 - a. Building lines.
 - b. Structural members.
 - c. Soil and drain piping.
 - d. Steam and condensate piping.
 - e. Sprinkler piping.
 - f. Vent piping.
 - g. Supply ductwork.
 - h. Exhaust ductwork.
 - i. Chilled water piping.
 - j. Domestic water piping.
 - k. Electrical conduit.
6. Locate operating and control equipment properly to provide easy access. Arrange entire mechanical work with adequate access for operation and maintenance.
7. Advise other trades of openings required in their work for the subsequent move in of large units of mechanical work.
8. Coordinate all items which will affect the installation of the work of this Division. This coordination shall include, but not be limited to, voltage, ampacity, capacity, electrical and

pipng connections, space requirements, sequence of construction, building requirements and special conditions.

9. When submitting Shop Drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

B. Sequencing Plan:

1. This project involves modifications in an operating building which will require sequencing of the construction and multiple scheduled utility outages to construct.
2. A proposed project construction sequence for critical project work is included on the drawings for Contractor reference.
3. Contractor shall submit a proposed project construction sequencing plan and coordination drawings outlining the specific steps for project construction including the proposed date and duration of all required utility outages to the UTHSC-H Project Manager and A/E team for review prior to beginning any work at the site.
4. The proposed project construction sequencing plan and coordination drawings shall sequence and coordinate the work of the General Contractor and all Subcontractors and shall be organized to minimize the quantity and duration of utility outages.
5. The requirement for a "Sequencing Plan" and "Coordination Drawings" shall not be construed as releasing the General Contractor or Subcontractors from their responsibility to Plan and Coordinate the installation of the work or as authorization for the General Contractor or Subcontractors to make unauthorized changes to the Construction Documents or the project design concepts.

C. Coordination Drawings:

1. Coordinate the work of all Subcontractors for this Division with the Contractors responsible for this and other Divisions. Provide, in writing (with copies to the Engineer, Architect and Owner) all information necessary for coordination to permit the work of the project, including all Divisions, to be installed satisfactorily and with the least possible interference or delay.
2. The Division 21, 22 and 23 Contractors, in coordination with Contractors responsible for other Divisions, shall prepare a complete set of construction "Coordination Drawings" which shall be completed and submitted to the Engineer, Architect and Owner within one (1) month after notice to proceed is given to the General Contractor. If the General Contractor or any Subcontractor allows any work to be installed before coordinating with the work of other Subcontractors, the necessary changes for field coordination shall be made without extra cost to the Owner, Architect or Engineer.
3. "Coordination Drawings" shall be drawn electronically and plotted at a scale of not less than 1/4" = 1'0" and shall be electronic 2D files with sections or 3D files. "Coordination Drawings" shall be submitted as electronic files plus either pdf files or plotted drawing output files with adequate detail for the Architect and Engineer to confirm that project coordination has been completed. Drawings shall show actual equipment being provided and shall maintain all design drawing space allocations, designated dimensions, ceiling heights, chase dimensions, room sizes and required service clearances for the actual equipment being provided. Deviations from ceiling heights,

chase dimensions, room sizes and similar requirements to the Construction Documents shall not be made without specific prior written authorization from the Architect.

4. "Coordination Drawings" for interior construction shall show the coordinated locations for equipment, ductwork, piping, conduit, busway, devices, etc. and shall show all ductwork, all busway and all pipe and conduit larger than 4" using double lines. Elevations shall be shown for all construction and horizontal dimensions from major construction to accessible column or building lines shall be shown. Where required for coordination, offsets shall be shown and sections shall be cut and drawn.
5. "Coordination Drawings" shall indicate loads and anchor/support points for all piping 8" and larger, for all racked piping, for all racked conduit 3" and larger, for all busway and for all suspended equipment. These drawings shall be submitted to the Structural Engineer for review and approval. Any special hangers, embeds, supports, reinforcing, etc. required by the Structural Engineer shall be provided at no additional cost to the Owner.
6. "Coordination Drawings" for all work routed underground or embedded in concrete shall show specific dimensions to accessible column or building lines and the burial depth of all underground utilities. Where existing utilities are located in the area where new utilities are being installed, dimensions and burial depth for existing utilities shall be shown on "Coordination Drawings".
7. The requirement for "Coordination Drawings" shall not be construed as releasing the General Contractor or Subcontractors from their responsibility to coordinate the installation of the work or as authorization for the General Contractor or Subcontractors to make unauthorized changes to the Construction Documents or the project design concepts.

1.18 MATERIALS AND WORKMANSHIP:

- A. General: Materials and equipment shall be new, of best grade and quality, and standard products of reputable manufacturers regularly engaged in the production of such materials and equipment.
- B. Workmanship: Work shall be executed and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed.
- C. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

1.19 SPACE REQUIREMENTS:

- A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearances for adjustments, repair, or replacement.
- B. Clearance: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.

- C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.
- D. Responsibility: Since space requirements and equipment arrangement vary for each manufacturer, the responsibility for initial access and proper fit rests with the Contractor.
- E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

1.20 SAFETY REGULATIONS:

- A. All mechanical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the mechanical work shall be provided by and operated by the Mechanical contractor.

1.21 DELIVERY, STORAGE AND HANDLING OF MATERIALS:

- A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.
- B. Scope: Work under this Division shall include, but not limited to:
 - 1. Shipping from point of manufacture to job site.
 - 2. Unloading, moving, and storage on site with proper protection as required.
 - 3. Hoisting and scaffolding of materials and equipment included in this Division.
 - 4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.
- C. Installation Coordination: All large pieces of apparatus which are to be installed in the building and which are too large to permit access through doorways, corridors, stairways or shafts shall be brought to the job by the Contractor and shall be placed in the spaces before enclosing partitions and structure are completed.
- D. Protection: All equipment, materials and apparatus stored outdoors, in unenclosed spaces or in enclosed spaces at the jobsite or at the Subcontractor's facilities shall be protected against temperatures ranging from 20°F to 105°F, rain, wind, hail and all other weather conditions that are common to the site location.
 - 1. Storage Outdoors: All equipment, materials and apparatus stored outdoors shall be cribbed up from the ground by Contractor and shall be covered with tarpaulins or other protective covering as required for protection. Provide temporary space conditioning inside protective enclosures as required to properly protect equipment, materials and apparatus.
 - 2. Storage in an Unenclosed Building: All equipment, materials and apparatus stored in an unenclosed building shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering as required for protection. Provide temporary space conditioning inside protective enclosures as required to properly protect equipment, materials and apparatus.
 - 3. Storage in and Enclosed Building: All equipment, materials and apparatus stored in an enclosed building shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering as required for protection. Provide temporary

space conditioning as required to properly protect equipment, materials and apparatus which are stored in unconditioned buildings from damage.

1.22 NOISE AND VIBRATION:

- A. General: Warrant the heating, ventilating, air conditioning systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended NC curves (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.
- B. Sound Testing: Equipment shall be sound tested as specified in the individual Sections. The test data shall be expressed in sound power levels with decibels referenced to 10^{-12} watts and in octave bands as set forth in current ANSI Standards. The sound testing shall be performed in a reverberant room. The room effect shall be defined as the sound power level (decibels referenced to 10^{-12} watts) minus sound pressure level (decibels referenced to 0.0002 microbar) shall be established at 10 dB. The additive "allowance for multiple air outlets" for the purpose of the sound test shall be considered as 5 dB in determining the sound power level per air terminal. The final sound pressure level test results shall be based on the above requirements unless noted or specified otherwise and shall not exceed the noise criteria curve limitations specified.
- C. Noise Level: Except in special areas listed separately, the noise level in occupied spaces shall be equal to, or less than, the "lowest value in the range" of the noise criteria curves for the particular space in accordance with Chapter 7, Table 11 of the 2001 Fundamentals Edition of the ASHRAE Handbook. The noise criteria curves shall be based on current ANSI Standard octave bands and a sound pressure level in decibels referenced to 0.0002 microbars. Sound levels within the occupied spaces must meet the criteria described above and with all building, wall partition, floor, and ceiling construction in place as they exist for the individual spaces. The attenuation through boundary construction of equipment rooms must be considered in selecting equipment for acceptable noise level.
- D. Verification: Should a question arise of whether noise and vibration in a particular space or piece of equipment meet the above criteria, the Contractor shall be responsible for providing the services of an approved vibration or acoustic consultant to verify criteria compliance.

1.23 ADJUSTING AND START-UP:

- A. Start-up Services: Where specified for any individual item of heating, ventilating, air conditioning, and plumbing equipment, provide a factory-authorized representative for testing, start-up of equipment, and instruction of Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.
- B. Lubrication: Provide a readily accessible means for lubricating all bearings and other machine parts. Extend a lubrication tube with suitable fitting to an accessible location and suitably identify it where lubrication fittings are concealed or inaccessible. Lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.
- C. Air Filters: Air filters shall be installed on all equipment so equipped prior to initial start-up. In addition, blanket filters shall be installed over coils, filters and over fan powered terminal unit

inlets as a pre-filter during construction. Final filters shall be installed prior to the owner's beneficial use (substantial completion)

- D. Testing, Adjusting and Balance: Refer to Section 23 05 93 for requirements.
- E. Operation Prior to Completion: When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Engineer's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or the date of substantial completion, whichever occurs first. Regardless of whether or not the equipment has or has not been operated the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all deficiency list items before final acceptance by the Owner. The date of final acceptance and the start of the warranty may not be the same date.

1.24 SITE CLEAN-UP:

- A. Clean-up: Each Contractor shall clean away from the job site all debris, surplus material and similar items, resulting from his work or operations, leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, ductwork, fixtures and similar items, leaving the installation in a first class, clean, operable condition.
- B. Clean Work Space: If the facility will remain occupied during the construction process, each Contractor shall clean up and maintain, at all times, areas visible to the public to prevent the appearance of a sloppy or careless work space. Employee trash shall be disposed of in a designated trash receptacle maintained by the contractor. All demolition or construction debris not designated for salvage by the Project Manager shall daily be collected and temporarily held in an area designated by, and in quantities allowed by, the owner or the general contractor, or the contractor shall be removed from the site by this contractor and disposed of properly off site.
- C. Salvageable Materials: Materials designated by the OR to be salvaged shall be stored in the building, at a location as directed by the OR and the contractor shall verify with the OR which materials are to be salvaged.
- D. Continuing Facilities Maintenance: In areas that contain equipment or systems that must be serviced, inspected, or maintained, no construction debris shall be allowed to block normal access paths or inhibit the required maintenance or service of those systems. This contractor shall immediately remove any debris that constitutes a hindrance to normal service.
- E. Directed Clean-Up: If the facility will remain occupied during the construction process, should, for any reason, the OR, the Architect or the Engineer notify the contractor of his failure to comply with a clean work space requirement, and the contractor ignores this requirement, the Owner shall retain the services of a clean-up crew to maintain a clean public work space and back charge the contractor for such contract costs.
- F. Daily Clean-Up: Each Contractor shall clean away from the job site all debris, surplus material, and similar items, resulting from his work or operations, on a daily basis leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, fixtures, and similar items, leaving the installation in a first class, clean, operable condition.
- G. Equipment Operation: When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he

properly supervises the operation, and has the OR's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first. Regardless of whether or not the equipment has or has not been operated the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all deficiency list items before final acceptance by the Owner. The date of final acceptance and the start of the warranty may not be the same date.

1.25 POLICIES AND PROCEDURES

- A. Employees: Employees of the contractor that are assigned to this project shall be competent, experienced personnel who have received training for their related tasks and in the operation of any equipment that they are to operate.
- B. Identification: Employees shall be uniformed or wear clothing that clearly distinguishes them as employees of the contractor or subcontractors authorized to provide services at this facility. In addition, employees shall have picture identification badges of a type acceptable to the Owner.
- C. Supervision: Each work crew on the project shall include a full time site foreman or supervisor.
- D. Contact: The contractor shall provide a contact point, available by phone or pager, who will respond immediately to problems, questions or concerns reported by the OR.
- E. Training: Employees shall be trained in any required safety precautions related to the equipment and materials that they are using.

1.26 FINAL REVIEW:

- A. General: Upon completion of the Work, perform a final test of the entire system.
 - 1. The system shall be operating properly with all water and air volumes balanced and all temperature controls adjusted.
 - 2. After the final test, any changes or corrections noted as necessary for the Work to comply with these Specifications or the Drawings shall be accomplished without delay in order to secure final acceptance of the Work.
 - 3. The date for the final test shall be sufficiently in advance of the Contract completion date to permit execution, before expiration of the Contract, of any adjustments or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the time allotted for completion of the Contract. Retests shall be conducted as directed and shall be of such time duration as necessary to ensure proper functioning of adjusted and altered items. Retests shall not relieve the Contractor of completion date responsibility.
 - 4. Certificates, including certificates of occupancy from local authorities and documents required herein, shall be completely in order and presented to the Engineer at least one week prior to the review.
- B. Qualified Person: Individuals knowledgeable of the systems and persons approved by the Engineer, shall be present at this final inspection to demonstrate the system and prove the performance of the equipment.

1.27 OWNER INSTRUCTION:

- A. General: This Contractor and appropriate factory-trained representatives shall provide to the Owner's representative the specified or manufacturer recommended training and instruction in the proper operation and maintenance of all systems and equipment and shall explain all warranties.
- B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by the Engineer.
- C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- D. Other Requirements: Refer to other Division 23 Sections for additional operator training requirements.

1.28 CONTRACTOR WARRANTIES AND GUARANTEES:

- A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 12 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. Equipment: All equipment bearing a manufacturer's guarantee, such as motors, compressors, condensers, heat exchangers, water heaters, blowers, controls, and similar items, shall be construed to have an extended guarantee to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.
- C. Start-up: The Mechanical Contractor shall provide instructions and equipment starting service on new equipment for one complete year after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION 23 01 00

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 23 00 10 - MECHANICAL SCOPE OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: Provide labor, materials, tools, machinery, equipment, appliances, and services necessary to complete the specified mechanical work of this Division. Coordinate Work with other trades to prevent conflicts without impeding job progress.
- B. Work Included: The Work includes, but is not limited to, the following systems, equipment, and services:
 - 1. Modifications to Base Building Air Distribution Systems including, but not limited to:
 - a. Sheet metal ductwork.
 - b. Fire/smoke dampers, balancing dampers and accessories.
 - c. Grilles, registers and ceiling outlets.
 - d. Insulation.
 - e. Acoustical treatment of ducts.
 - f. Sound attenuating equipment, lined elbows and transfer ducts.
 - g. Additional items as specified, indicated or implied on the Drawings.
 - 2. Relocation of existing building space temperature sensors.
 - 3. Modifications to the Base Building Plumbing System including, but not limited to:
 - a. Plumbing fixtures and trim.
 - b. Domestic hot water supply piping.
 - c. Domestic cold water supply piping, including connections to the Base Building valved connections.
 - d. Sanitary waste and vent piping, including connections to Base Building capped stub-outs.
 - e. Insulation, controls, safety devices, vibration isolation and similar items.
 - f. Additional items specified, indicated or implied on the Drawings.
 - 4. Modifications to the existing Building Fire Protection System including, but not limited to:
 - a. Wet-pipe automatic sprinkler system modifications.
 - b. Additional items specified, indicated, or implied on the Drawings.

5. Connections to equipment furnished by the General Contractor or other Divisions.
6. Connections for Tenant-furnished equipment where shown on the Drawings or specified.
7. Testing, and provisions for balancing and adjusting of mechanical and Plumbing systems as specified.
8. Additional items as shown on the Drawings or specified.
9. Structural Openings:
 - a. The Mechanical Contractor shall be responsible for coordinating all required openings in existing construction with the General Contractor and Landlord and shall be responsible for cutting or drilling required openings in a manner which is acceptable to the Landlord. Cutting and drilling operations shall be performed at times which are acceptable to the Landlord.
 - b. Roof curbs and skids for mechanical equipment will be furnished by the Mechanical Contractor who shall locate, install, and provide the counterflashing. Factory curbs may be used pending approval of installation and location by the Structural Engineer.
 - c. Except as otherwise indicated on the Drawings, all holes of area less than 150 square inches required through concrete floors, precast concrete, masonry, and similar items, shall be provided by the Mechanical Contractor. All holes required through post-tensioned concrete floors and roof and all other holes that proper mechanical installation require to be of a larger area than 150 square inches will be provided by the Contractor for precast construction at locations determined by this Contractor. Any cutting and patching for holes required for proper mechanical installation where information on sizes and locations is not provided to the Construction Manager in sufficient time shall be the responsibility of the Mechanical Contractor. All cutting and patching shall be subject to the direction and approval of the Architect.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Refer to specific Sections of the Specifications for equipment.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Installation shall be in accordance with the Specification section pertaining to the individual equipment.

END OF SECTION 23 00 10

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 23 03 00 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide basic materials and methods for mechanical construction as shown, scheduled, indicated, and specified.
- B. Types: The types of basic materials and methods required for the project include, but are not limited to:
 - 1. General piping installation.
 - 2. Hangers and supports.
 - 3. Miscellaneous steel.
 - 4. Sleeves.
 - 5. Escutcheon plates.
 - 6. Exposed piping.
 - 7. Pipe cleaning and sterilization.
 - 8. Openings, cutting and patching.
 - 9. Access doors.
 - 10. Firestopping for piping and ductwork.
 - 11. Fire-rated partitions.
 - 12. Flame spread properties of materials.
 - 13. Penetrations, flashing, and seals.
 - 14. Cleaning and painting of mechanical work.
 - 15. Mechanical system identification.
 - 16. Warning signs and operational tags.
 - 17. Equipment connections.
 - 18. Rotating shafts.
 - 19. Belt and coupling guards.
 - 20. Bearings.
 - 21. Equipment housekeeping pads and anchor bolts.
 - 22. Miscellaneous curbs and supports.
 - 23. Device mounting heights.

24. Demolition and work within existing buildings.

1.3 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Pipe fabrication drawings.
 - 2. Cut sheets on pipe hangers and supports, escutcheons, access doors, fire stopping materials, and miscellaneous curbs and supports.
 - 3. Cut sheets and samples of mechanical identification products.
 - 4. Additional information as required in Section 23 00 01, "Mechanical General Provisions".

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver components in factory-fabricated water resistant packaging.
- B. Handle components carefully to avoid damage to components, enclosures, and finish.
- C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General: Refer to Part 3 of this Section and other Division 23 sections for basic mechanical products and materials.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATION:

- A. General: The Contractor shall provide all piping system components as shown on the Drawings or necessary to complete the working system in accordance with the intent of the Drawings and Specifications, a complete system of piping, all valves as indicated or as necessary to completely control the entire apparatus and all appurtenances. The Piping Drawings are diagrammatic and indicate the general location and connections.
- B. Erection: Piping shall be properly supported and adequate provisions shall be made for expansion, contraction, slope and anchorage. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked in place without springing or forcing. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burr and cutting slag removed by reaming or other approved cleaning methods. All changes in direction shall be made with fittings, except that bending of pipe will be permitted provided a hydraulic pipe bender is used. Bent pipe showing kinks, wrinkles, or other malformation will not be acceptable.
- C. Concealed and Exposed Piping: All piping in finished areas shall be concealed, unless otherwise noted. Piping exposed in mechanical rooms and other locations as noted shall be installed in an orderly manner and parallel with or perpendicular to building lines. Exposed piping in occupied areas shall be routed tight to the structure or as high as is possible.
- D. Grading: All piping shall be carefully installed so as to eliminate traps and pockets in pressurized lines and to maintain flow in gravity flow lines. Where air pockets and traps

cannot be avoided, provide valved hose connections for water traps and valved automatic air vents for air traps. The Contractor shall consider pipe grading requirements when coordinating pipe routing for the project. Pipe slope shall be maintained throughout the project. Waste and vent piping shall be sloped in accordance with the applicable codes. Pressurized plumbing piping systems shall be sloped to drain points. HVAC water piping systems shall be graded up 1/16" per 10 lineal foot of horizontal run to air vent locations and down 1/16" per 10 lineal feet of horizontal run to drain locations. Grade all steam piping 1/4" per 10 lineal feet of horizontal run toward steam traps and slope all steam condensate piping 1/4" per 10 lineal feet of horizontal run toward condensate receivers.

- E. Arrangement: Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. All valves and specialties shall be placed to permit easy and proper operation and access, and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. Tapered reducers shall be used wherever changes in pipe sizes occur in mains. Bushings will not be permitted. The use of bull head tees or other high pressure drop configurations will not be permitted.
- F. Welding: All welded joints in piping shall be continuous metallic arc or gas fusion welds connecting pipe ends which are beveled to 37-1/2 degrees before welding. The use of backing rings will not be acceptable. All taps shall be made using proper weld fittings. No "burn-ins" will be allowed. Gas torch cuts shall be true and free from burned metal. Clean pipe surfaces to be welded immediately prior to welding. Welded pipe joints shall be properly aligned with no weld material or bead projects in into the pipe. All weld procedures shall be in accordance with requirements of the American Welding Society and shall be performed by certified welders. Documentation of welder certification shall be available if requested. All welding operations shall conform to the latest recommendations of the American Welding Society and to Section Six of Power Piping, ANSI B31.1 1973; B31.3 for steam piping. All qualifying tests, welding and stress relieving procedures, shall, moreover, be in accord with Standard Qualification for WELDING PROCEDURES, WELDERS AND WELDING OPERATORS, APPENDIX A, SECTION 6 of the Code, current edition. In no cases shall Schedule 40 pipe be welded with less than three passes including one tack, one filler, and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one tack, two fillers and one lacer. Welds lacking penetration shall be removed. Internal and external cracks shall be ground down and removed.
1. All weld fittings shall be USA factory made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9 latest edition, as made by aNVIL, Tube Turn, Hackney, Taylor Forge, or Ladish Company. Long radius fittings shall be provided for all 90 degree and 45 degree elbows. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fitting selected at random. Complete test reports may be required for any fittings selected at random. Only one manufacturer of weld fittings will be approved for each project. Fittings which have been machined, remarked, printed or otherwise produced domestically from imported forgings or materials will not be acceptable. Each fitting shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these Specifications.

2. Piping and fittings shall be welded and fabricated in accordance with ASME/ANSI and the latest edition of Standard B31.1 from the Code for Pressure Piping for all systems, and B31.3 for Steam and Condensate systems. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
 3. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal.
 4. Align piping and equipment so that no part is offset more than 1/16". Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
 5. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
 6. Contractor shall not split, bend, flatten or otherwise damage piping before, during or after installation. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.
 7. In no case shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two fillers and one lacer. In all cases, however, the weld must be filled before the cap weld is added.
 8. All welds are subject to inspection, visual and/or X-ray, for compliance with specifications. The Owner will, at the Owners option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the Owner. The Contractor shall be responsible for all labor, material and travel expenses involved in the reinspection and retesting of any welds found to be unacceptable. In addition, the Contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1 and B31.3 due to the discovery of poor, unacceptable, or rejected welds.
 9. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding, and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.
- G. Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be unpended and hammered to remove all shavings and foreign material.
- H. Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.
- I. Expansion and Contraction: Provisions for expansion and contraction of piping shall be provided by expansion loops, bends or expansion joints to prevent injury to connections, piping, equipment or the elements of the building.

- J. Anchors: Pipe anchors shall be provided and installed at each end of piping runs which require expansion loops or joints, and where indicated on Drawings. Anchors shall be fabricated of rigid structured steel members firmly secured to the building structure.
- K. Guides: Pipe guides shall be provided and installed on piping as shown on Drawings and as necessary to properly fulfill function of expansion loops.
- L. Unions: Shall be installed on all bypasses, ahead of all traps, at all connections to equipment, where shown on the Drawings or where required to facilitate removal of equipment.
- M. Escutcheons: Spring clamp plates (escutcheons) shall be provided where pipes are exposed in finish locations of the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain or approved pattern and shall be set tight on the pipe and to the building surface.
- N. Protection: All open ends of pipes and equipment shall be properly capped or plugged during construction to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton, waste or similar materials are not acceptable.
- O. Pipe Sizes: If the size of the piping is not clearly evident in the Drawings, the Contractor shall request instruction as to the proper sizing.
- P. Connections Between Copper and Steel Pipes: Connections shall be made with dielectric couplings, flanged dielectric unions, CTS copper flanged adapter or nylon bushings temperature and pressure rated for the service at the point of installation.
- Q. Exterior Underground Piping: All exterior underground piping shall be installed with a minimum of 30" of earth or equivalent cover, except where specifically shown otherwise or permitted by the Architect/Engineer. Generally more cover shall be provided if the grades of the lines involved and the finished grade elevations established at the site will permit.
- R. Pipe Layout: All piping shall be installed in accordance with Plans and Specifications and according to all applicable local and state codes. Minor piping revisions due to substituted equipment are acceptable provided they are indicated on piping fabrication drawings. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from laying on the ground shall be removed.
- S. Piping fabrication drawings shall be submitted for all piping in the Central Plant, mechanical rooms, and for equipment connections and all other areas requiring coordination with other trades.
 - 1. Pipe fabrication drawings shall be double line drawings to scale on 1/4" scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, system type, insulation, hangers, support requirements, anchors, guides, expansion joints and loops, pipe elevations and other information required for coordination with other trades and fabrication of piping.

2. Pipe fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval. Refer to Section 23 01 00 for additional shop drawing requirements.

3.2 HANGERS AND SUPPORTS:

- A. General: Provide pipe hangers and supports as specified. All horizontal and vertical piping shall be thoroughly and substantially supported in ANSI B31.1 Standard Code for Pressure Piping and Manufacturers' Standardization Society MSS SP-69 Pipe Hangers and Supports - Selection and Application. Comply with local codes and standards for pipe and equipment support and anchorage. Pipe supports shall be of material that will prevent electrolytic action. The design, type, spacing and application of all hangers, supports, anchors and guides shall comply with the above standards. Hanger rod clamps and inserts shall be as recommended by the clamp or insert manufacturer for the intended use and shall be approved in writing by the Structural Engineer. All methods of attachment to the structure and the use of afterset inserts shall be approved in writing by the Structural Engineer. **The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts.** Reinforcement at inserts shall be provided as required to develop the strength required.
- B. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.
- C. Acceptable Manufacturers: The model numbers listed in the Specification establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of this Specification:
 1. Anvil International.
 2. B-Line.
 3. Central Iron Manufacturing Company.
 4. F & S Manufacturing Company.
 5. Hubbard Enterprises/Holdrite
 6. The Michigan Hanger Company.
- D. Inserts: Provide Anvil Fig. 282 or equal inserts for all pipe, ductwork and equipment suspended from new concrete construction. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, and similar items spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel. All inserts shall be galvanized. Cast-in-place concrete inserts are preferred over powder-actuated fasteners or expansion anchors, especially in post-tension slab applications. Place cast-in-place anchors prior to concrete pour. For small-bore piping, use Hubbard Enterprises/HOLDRITE #125 series brackets or owner approved equipment.
- E. Fasteners: Fastening of pipes, conduits, and similar items in the building shall be as follows: To wood members - by wood screws; to masonry - by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of

masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to new concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. All fasteners shall be cadmium plated or galvanized. **Power-actuated fasteners (shooting) will not be acceptable under any circumstances.**

- F. Piping in Multiple Parallel Runs: Provide galvanized structural channels or angles with Anvil Fig. 137/137 C or equal galvanized U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Coated U-bolts shall be provided for uninsulated glass or copper pipe. Select and size members for weights to be carried and span dimensions between supports.
- G. Piping in Single Runs: Provide Anvil Fig. 260 or equal adjustable clevis hangers with a nut above and below the hanger on the hanger rod. All hangers shall be galvanized.
- H. Copper Pipe Hangers: Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Anvil Fig. CT 99C or equal, adjustable plastic coated, copper-plated tubing rings. Hangers supporting and contacting brass or copper lines 4" and larger shall be Grinnell Fig. 260 or equal, galvanized, adjustable clevis, with a nut above and below the hanger on the support rod and approved neoprene isolating material between pipe (or tubing) and hanger. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Anvil Fig. 260 or equal, galvanized, adjustable clevis, with a nut above and below the hanger on the support rod and sized to fit the outside diameter of the insulation and hanger. Isolate all copper or brass lines from ferrous metals with approved dielectric materials.
- I. Hanger Rod: Provide cadmium-coated or galvanized hanger rods and nuts of required length. Rods shall be coated or galvanized after threading. Rods shall be cold galvanized after cutting. All hanger rods shall be trimmed neatly so that no more than one inch (1") of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage. Rod diameters shall be as follows:

<u>Pipe Sizes</u>	<u>Rod Diameter</u>
3/4 - 2"	3/8"
2-1/2 - 3"	1/2"
4 - 5"	5/8"
6"	3/4"
8 - 12"	7/8"
14 - 18"	1"

- J. Riser Clamps: Provide Anvil Fig. 261/261 C or equal galvanized riser clamps with equal bearing on each end. Riser clamps for copper tube shall be plastic coated.
 - 1. Riser clamps shall be isolated from the structure by use of Hubbard Enterprises Holdrite #274 or #278 riser pad or equal.
- K. Pipe Supports in Chases and Partitions: Horizontal and vertical piping chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved

clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp or other approved method. All copper or brass lines shall be isolated from ferrous metals with electrical tape or other dielectric materials to prevent electrolytic action.

L. Saddles and Shields:

1. Saddles for Horizontal Insulated Piping Without Vapor Barrier: At each hanger or support on horizontal runs, provide Anvil Fig. 160 or equal black steel saddles, as applicable. Shields as described below may be used instead of the saddles.
2. Shields for Horizontal Insulated Water Piping With Vapor Barrier: At each hanger or support for water piping, provide a half section of preformed cellular glass or rigid calcium silicate blocking, with jacket of adjacent insulation brought across unbroken, supported on Anvil Fig. 167 or Anvil 260 ISS or equal semicircular galvanized steel shields. Shields for pipe 4" and smaller shall be 12" long; shields for pipe 5 to 8" shall be 18" long; and shields for larger pipe shall be 24" long.

M. Roller Supports: Provide Anvil Fig. 171/177 or equal adjustable, cast iron pipe roll supports for support of horizontal piping installed in racks, beam supports, suspended and where shown on the Drawings.

N. Guides: Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops, expansion joints, and ball joints.

O. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.

1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturer's written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.
2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and 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.

P. Provisions for Movement:

1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to any pipe or connected equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations.
3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.

- Q. Spacing: Install hangers and supports in piping systems to remove stress from equipment flanges and rotating equipment. The following table gives maximum hanger spacing for copper and steel lines. Hangers shall be more closely spaced where required by the conditions of the installation in order to prevent sagging, excess load on structure and hangers, undue strain on equipment, noise transmission, etc. A hanger shall be placed within 2' of each elbow or tee with a minimum support of one hanger per joint or fitting and at each rise, drop, and trap. Maximum hanger and support spacing shall be as follows and as specified elsewhere:

<u>Trade Pipe Size</u>	<u>Maximum Spacing</u>
1/2"*	5'
3/4"	6'
1" and 1-1/4"	7'
1-1/2"	9'
2"	10'
2-1/2"	11'
3"	12'
4"	14'
5"	16'
6"	17'
8"	19'
10"	22'
12"	23'

* Includes all sizes of cast iron and nonmetallic piping. Cast iron pipe sections exceeding 5 feet in length can be supported on maximum 10 foot centers provided hangers are installed within 18 inches of each joint and fitting. Provide rolled, galvanized sheet metal pipe shields between nonmetallic pipe hangers as required to prevent any visible nonmetallic pipe sag between hangers.

- R. Sway Bracing: Where hanger lengths for cast iron piping exceed 18 inches, sway bracing shall be provided per CISPI recommendations, to prevent pipe shear.
- S. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.
- T. Midspan Support: For vertical midspan support of piping 4" and under, use Hubbard Enterprises/Holdrite Stout Brackets TM in conjunction with Hubbard Enterprises/HOLDRITE Stout clamps or two hole pipe clamps (MSS Type 26).
- U. Vibration Isolation: Refer to Section 23 05 48, "Vibration Isolation", for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.
- V. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.
1. Cast iron soil pipe shall be supported at the base and at each story level, but in no case at intervals greater than 25'.
 2. Steel pipe shall be supported at the base and at not less than every other story level, but in no case at intervals greater than 30', except that grooved-piping systems shall be supported at each pipe section.

3. Copper tube shall be supported at each story level, but in no case at intervals greater than 25'.
4. Plastic pipe shall be supported at mid point between floors to prevent movement, but in no case at intervals greater than 10'.

- W. Finish: All steel and iron hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, brackets, shall be hot dip or electro-galvanized after fabrication for indoor applications and hot dip galvanized after fabrication for exterior applications. Rods shall be electro-galvanized or cadmium plated after threading, for indoor applications and hot dip galvanized after fabrication for outdoor applications. Universal concrete inserts shall be galvanized.
- X. Fire Protection Piping Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards, using UL-listed and labeled support components. Refer to Section 21 12 00 for additional requirements.
- Y. Secondary Pipe Positioning and Supports: Makeshift, field devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/HOLDRITE support system or owner approved equipment.

3.3 MISCELLANEOUS STEEL:

- A. All miscellaneous steel members, angles, rods, supports, and similar items specified or required for this project shall be galvanized for indoor use or hot dipped galvanized for exterior use and where exposed to ambient conditions. All required miscellaneous steel shall be provided by this Division..

3.4 SLEEVES:

- A. General: Provide sleeves around all piping passing through masonry, CMU and concrete walls and partitions, suspended slabs, plaster or dry wall ceilings, structural members, other building features and where shown on the drawings. No sleeves shall be installed through any concrete beam or other deep projections without written approval of the Architect/Engineer.
- B. Partitions: Sleeves shall be required for piping passing through rated dry wall and plaster partitions. Sleeves shall be set in dry wall mud or plastered in and the pipe passing through the sleeve shall be sealed as outlined in Piping Fire Stops and Seals. Sleeves are not required for piping passing through nonrated dry wall or plaster partitions. Nonisolated piping shall be mudded in and isolated piping shall have the opening mudded to within 1/2" of the pipe and an elastomeric caulk shall be installed in the opening around the pipe or insulation.
- C. Plumbing Storm, Waste and Vent: Sleeves shall not be required for storm, waste or vent piping through slabs on grade or for piping passing through precast structure. Where piping passes vertically through precast structures without sleeving, adequate provisions shall be made to prevent water leakage through slabs where applicable.
- D. Placement: This Contractor shall be responsible for the timely placement of sleeves in construction. If sleeves are not placed during construction, this Contractor shall secure written permission to perform a core drill or cut and patch installation at no cost to the Owner. No piping shall pass through the above obstructions without sleeves, unless noted otherwise.

- E. Sizing: Sleeves shall be one size larger than the pipe passing through the sleeve, except where larger sizes are required for mechanical seals. Where insulated piping passes through construction, sleeves shall be one size larger than the outside diameter of the insulation. All sleeves in floors shall extend 2" above the finished floor. Sleeves through vertical construction shall be minimum 18 gauge galvanized steel. Sleeves through horizontal construction shall be minimum 16 gauge galvanized steel except at pipe riser supports. Sleeves at riser supports for 3" and smaller pipe shall be Schedule 40 galvanized pipe sleeves. Sleeves for riser supports for 4" and larger pipe and for pipe passing through exterior building construction below grade shall be Thunderline Corporation Type WS or an approved equal.
- F. Installation: At no point shall the pipe or its insulation touch the sleeve it passes through. Seal all sleeves which are not in exterior construction below grade or rated construction with an approved non-hardening mastic. Seal sleeves through fire rated construction as specified under "FIRE STOPPING FOR PIPING AND DUCTWORK" and as detailed on the Drawings. Sleeves below grade shall be sealed with segmented annular seal, refer to Paragraph 3.14.
- G. Existing Construction: Sleeves are not required where new openings are core-drilled into existing construction, unless noted otherwise on the Drawings.

3.5 ESCUTCHEON PLATES:

- A. General: Except as otherwise noted, provide chrome-plated brass floor and ceiling escutcheon plates around all pipes, and similar items passing exposed through walls, floors, or ceilings, in any finished spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the conduit. Plates will not be required for piping where pipe sleeves extend above finished floor. Provide sheet metal trim plates at all penetrations exposed to view of building occupants, unless directed otherwise by the Architect. All equipment rooms are classified as finished spaces.
- B. Type: Escutcheon plates shall be Dearborn Brass Company, Fig. No. 1149 through 1152.

3.6 EXPOSED PIPING:

- A. General: All exposed piping to plumbing fixtures and connected equipment in finished areas shall be polished chrome plated unless noted otherwise on the drawings. This shall include piping, fittings and valves. Polished chrome plated sleeves may be used over supply, waste and vent piping provided that the finished installation presents the appearance of a fully chrome plated system.

3.7 PIPE CLEANING AND STERILIZATION:

- A. HVAC Piping: All piping shall be cleaned following successful pressure testing of pipe. Piping shall be completely drained following pressure testing and then filled with clear water and pipe cleaning treatment (Mogel C-641 or approved equal) to the suppliers recommended concentration required to rid the system of rust, dirt, piping compound, mill scale, oil, grease, and any other foreign material. The system shall then be circulated per the suppliers recommendations. Following cleaning, each system shall be drained, refilled and then continuously filtered or flushed until clean water is obtained. Strainers shall be removed and cleaned after each flushing. Refer to Section 23 25 00, "HVAC Water Treatment", for water treatment for these systems. After the system has been pressure tested, treated with pipe cleaning treatment and rinsed with clear water to remove the cleaning treatment, a 5 micron in-line filter may be installed in the system, in lieu of continuous water flushing, to clear the piping of construction debris. Each system being filtered shall be pumped continuously and

the filter shall be cleaned once every 24 hours until no visible filtered matter is present in the filter after 24 hours of circulation. After the cleaning process is complete, the filters shall be removed from the system and all strainers shall be cleaned prior to putting the piping system into operation. Provide temporary loop piping and fill/drain valves as required to allow new piping to be flushed and circulated until the system is clean, prior to making connections to the Base Building piping system.

- B. Domestic Water Piping: All potable water piping and tanks shall, after successful pressure testing, be thoroughly flushed with clear water and then sterilized. Sterilization shall be with either liquid chlorine or chlorine gas of adequate volume to give a concentration of 50 ppm based upon the volume of the system being treated. A minimum residual chlorine level of 5 ppm shall remain in each system for a minimum of 24 hours. After sterilization, all piping shall be thoroughly flushed. The above are minimum requirements and all sterilization procedures shall be in strict accordance with all local codes and authorities having jurisdiction.

3.8 OPENINGS, CUTTING AND PATCHING:

- A. General: The Contractor shall be responsible for coordinating openings in the building construction for installation of mechanical systems. Coordinate penetrations and place equipment in time to avoid cutting new construction. Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of mechanical work. Except as individually authorized by the Architect/Engineer, cutting and patching of mechanical work to accommodate the installation of other work is not permitted.
- B. Cut and Patch: Cut and patch walls, floors, and similar items resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.
- C. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for piping and similar items shall be core drilled to exact size.
- D. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no change in Contract amount. Undertake no cutting or patching without first securing written approval from the Architect/Engineer. Patching shall create a surface which is structurally and aesthetically equal to the surface surrounding the area patched and shall be performed by the trade whose work is involved, at no change in the Contract amount.
- E. Protection: Openings through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.
- F. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes. Restoration work shall be performed by the trades who originally installed the work being restored and shall be performed at no cost to the Owner or Architect/Engineer.
- G. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided

during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, and similar items shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

- H. Plaster: All electrical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.
- I. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.9 ACCESS DOORS:

- A. General: This Contractor shall provide wall or ceiling access doors for installation in finished surfaces for unrestricted access to all concealed items of mechanical equipment.
- B. Types: Doors shall be factory-finished as noted below and turned over to the General Contractor for installation, refer to finish painting requirements specified herein below. Doors shall be as manufactured by Inryco/Milcor or an approved equal in the following styles:
 - 1. Drywall Construction Inryco/Milcor Style DW with gray prime finish.
 - 2. Finished Acoustical Ceiling Tile Inryco/Milcor Style AT with door designed for tile insert.
 - 3. Finished Plaster Ceiling or Walls Inryco/Milcor Style WB-PL with door designed for finish plastering.
 - 4. Masonry Walls Inryco/Milcor Style M with gray prime finish.
 - 5. Fire Rated Construction Inryco/Milcor Fire Rated Access Door with gray prime finish.
 - 6. Fire Rated Ceiling or Ceiling Assembly Inryco/Milcor Style ATR with door designed for tile insert.
- C. Selection: Access doors shall be furnished with a continuous piano hinge with screwdriver-operated flush locks and shall be a minimum of 12" x 12". Larger sizes shall be furnished where required for proper access.
- D. Approval: Access doors shall not be installed until location and style have been approved by the Architect.

3.10 FIRESTOPPING FOR PIPING AND DUCTWORK:

- A. General: Provide a UL Systems Classified, intumescent material capable of expanding up to eight to ten times when exposed to temperatures beginning at 250°F for sealing all holes or voids created to extend mechanical system piping, ductwork and other components through fire-rated floors and walls and other fire rated construction to prevent the spread of smoke, fire, toxic gas and water. The fire barrier system shall meet the fire test requirements and hose stream test requirements of ASTM E119-73.
- B. Fire barrier products shall be used to create through-penetration fire stop systems as required, with a minimum fire rating equal to the rating of the construction being penetrated. All fire stop systems shall be listed in the Underwriter's Laboratories Building Materials Directory, Through Penetration Firestop Systems (XHEZ).
- C. The products manufactured by 3M/Electrical Products Division or an approved equal are acceptable subject to Shop Drawing submittal approval.

- D. Install fire stop materials according to the following UL Systems Classifications and manufacturer's recommendations:

<u>OPENING TYPE</u>	<u>UL SYSTEM CLASSIFICATION NUMBER</u>
Metal Pipe Through Round Openings	No. 49, No. 95, and No. 147
Insulated Metal Pipe Through Round Openings	No. 91, No. 147, and No. 64C
Metal Pipe Through Large Openings	No. 93
Blank Openings	No. 92, No. 102, and No. 61
Glass Pipe Through Opening	No. 90b
Plastic Pipe Through Opening	No. 64b and No. 148
All Other Firestop Systems	Per manufacturer's recommendations

- E. Provide fire rated insulation blankets around ductwork and piping where shown on Drawings. Blankets shall be one inch (1"), 8 pound density thermo ceramic material, Thermo Ceramics Kas-Wool Fire Master Series thermal blankets or and approved equal. Blankets shall be wrapped to provide continuous coverage and be secured with stainless steel bands in accordance with the manufacturer's UL-listed installation instructions.

3.11 FIRE-RATED PARTITIONS:

- A. Coordinate locations of piping in fire-rated partitions so not to effect the fire rating of the partition. Notify the Architect/Engineer in writing where additional construction is required to maintain the partition fire rating.

3.12 FLAME SPREAD PROPERTIES OF MATERIALS:

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255 (1984), "Method of Test of Surface Burning Characteristics of Building Materials". The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, and similar items specified for each system, and shall not exceed a smoke-developed rating of 50.

3.13 PENETRATIONS, FLASHING, AND SEALS:

- A. Pipe sleeves, pitch pockets, and flashings compatible with the roofing and waterproofing installation shall be provided for all roof and wall penetrations and roof-mounted equipment and supports. Coordinate flashing details with the Architectural details and the roofing/waterproofing Contractors.
- B. Segmented Annular Seals: Seal the openings around piping which penetrate the exterior construction using segmented annular seals to prevent the entry of water and other foreign material. Segmented annular seals shall be Thunderline Corporation Type LS Series link seals or an approved equal. Seals shall be Style C insulating type for standard service at temperatures up to 250°F. Seals shall be Style T high temperature service at temperatures up to 450°F. Sleeves for use with annular seals shall be Thunderline Corporation Type WS or an approved equal.

3.14 CLEANING AND PAINTING OF MECHANICAL WORK:

- A. Prime, protective and touch-up painting is included in the Work of this Division. Finish painting in equipment spaces, concealed locations, and other locations not exposed to the view of building occupants is included in the work of this Division. Finished painting in areas exposed to the view of building occupants is specified under Division 9.

- B. All equipment furnished by the mechanical subcontractor shall be delivered to the job with suitable factory protective finish.
- C. Mechanical equipment with suitable factory-applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect and in a color selected by the Architect. Where factory-applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory-fresh condition by competent refinishers using the spray process.
- D. All equipment not finished at the factory shall be given a prime coat and then finish painted with two coats of enamel in a color as directed by the Architect/Engineer. No nameplates on equipment shall be painted, and suitable protection shall be afforded such plates to prevent their being rendered illegible during the painting operations.
- E. All uninsulated black steel piping, hangers, supports, and similar items shall be given two coats of primer. Where exposed to outdoor weather or exposed to view in equipment rooms, uninsulated black steel piping shall be primed and finished with two coats of enamel in colors as directed by the Architect/Engineer.
- F. Concealed fire protection and plumbing piping shall **not be painted**. Uninsulated plumbing and fire protection piping, where exposed to view in equipment rooms, shall be primed and finished with two coats of enamel in colors as directed by the Architect/Engineer.
- G. All insulated piping and equipment in mechanical/electrical rooms where exposed to view shall be primed and finish painted with two coats of enamel in colors as directed by the Architect/Engineer or Owner's Representative; and where concealed in furrings, chases, or suspended ceilings, need not be painted.
- H. All grilles and registers will be furnished with a factory-applied finish. Should the plans indicate that certain grilles and registers be furnished with a factory-applied prime coat for field painting, the cores shall be removed for painting under Division 9. The frames, after installation, shall be given two coats of enamel. The cores shall be spray painted with two coats of enamel, and shall be reinstalled in the frames only after both cores and frames are thoroughly dry. In such cases the color of the enamel finish shall be as directed by the Architect/Engineer.
- I. All equipment in the Central Plant, whether insulated or not, shall be field painted with two coats of suitable enamel in a color as directed by the Architect/Engineer.
- J. The surfaces to be finish-painted shall be prepared as follows:
 - 1. Galvanized and black steel surfaces shall be fully cleaned and painted with one coat of galvanized metal primer.
 - 2. Aluminum surfaces shall first be fully cleaned painted with one coat of zinc chromate primer.
 - 3. Cast iron pipe shall first be fully cleaned and painted with a "nonbleed" primer.
 - 4. Insulated surfaces shall be sized and primed using materials recommended by the insulation manufacturers.
- K. All ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, under floor and above ceilings shall be painted with two coats of zinc chromate primer as the construction progresses to protect against deterioration.

- L. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during the painting operation.
- M. Before painting, all surfaces to be painted shall be suitably prepared. This shall include removing all oil, rust, scale, dirt, and other foreign material. Surfaces shall be made smooth by grinding, filing, brushing, or other approved method. In the painting operations, the primer for metal surfaces shall be of the zinc dust type unless specified otherwise, and where finish painting is specified, it shall be painted using materials and colors selected and approved by the Architect/Engineer. Refer to Division 9 for additional requirements.

3.15 MECHANICAL SYSTEM IDENTIFICATION:

A. Identification of Equipment:

1. All pieces of major mechanical, plumbing and fire protection equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.
2. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, controls, devices and similar items by marking them. All items of equipment, controls, devices and similar items shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same designation as shown on the Drawings, where applicable.
3. Equipment nameplates shall be three ply laminated plastic, a minimum of 3/32" thick, black-white-black for equipment on normal power, red-white-red for equipment on emergency power, and blue-white-blue for equipment on UPS power. Letters shall be similar to Roman Gothic of a size that is legible (1/2" minimum for description and 3/8" minimum for supplementary text) and appropriate to the application. Attachment of nameplates shall be by stainless steel screws. Rivets or adhesives are not acceptable.
 - a. Mechanical, Plumbing and Fire Protection equipment to be identified includes: All condensing units, computer room air conditioning units, HVAC terminal units, fans, water heaters, control panels, fire/smoke dampers, motorized automatic dampers, and other major pieces of mechanical equipment.
 - b. Nameplates on powered equipment shall indicate the source feeding equipment and shall indicate variable speed, time delay operation, firefighter's override operation, etc., where applicable.

Example:

AHU 28
Fed from DPA-3
Room 1.102
Two Speed

- c. Individual controls and pilot lights on controllers and control panels shall have nameplates showing the device function.
- d. HVAC terminal units shall be identified with a permanently attached engraved name tag, as specified for equipment. In addition, the terminal unit designation shall be clearly marked in 6" high letters on the bottom of the unit using a black felt tipped marker.

- B. Valves: Valves shall be marked with 1-1/2" diameter aluminum or engraved plastic tags securely attached to valve stems with "S" hooks.
1. Prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:
 - a. HPS-1-3 High Pressure Steam - 1st Level - Valve No. 3.
 - b. CHS-2-4 Chilled Water Supply - 2nd Level - Valve No. 4.
 2. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to only those valves the functions of which are not obvious. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged.
 3. Valves at water heaters and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2-1/2" wide by 1-1/2" high with these color codings: red = normally closed; green = normally open; blue = open in winter, closed in summer; and yellow = closed in winter, open in summer. Tags should be engraved on both sides.
- C. Piping: Piping at major equipment, in all equipment rooms where exposed, where concealed in accessible locations and where concealed behind access doors or panels shall be color coded as to type of use, service and direction of flow in accordance with the latest edition of ANSI A13.1. Markers shall be located at each valve, at entries through walls and on 20'centers on straight runs of pipe. Piping concealed in accessible locations shall be marked on 50'centers on straight runs of pipe and at all changes in direction. Labels shall have color coded backgrounds with 1/2" to 2" high lettering, depending on pipe size.
1. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.
 2. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, 3/4" through 6". For piping systems larger than 6", use Seton or Brady strap on markers.
 3. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems". Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
 4. Pipe markers, zone identification and arrow markers shall be provided on, but not limited to, piping of the following systems:
 - a. Condenser water supply.
 - b. Condenser water return.
 - c. Domestic cold water supply.
 - d. Domestic hot water supply.
 - e. Domestic hot water return.
 - f. Sanitary sewer/vent.
 - g. Acid waste/vent.
 - h. Fire protection.

- D. Manufacturers: Acceptable manufacturers are Seton Nameplate Corporation, W.H. Brady Company or Westline Company.
- E. Piping Drawings: Provide a schematic diagram of each piping system **[and mechanical room]**, showing each valve with its tag designation and location. Laminate diagrams and install under framed polycarbonate at locations as directed by the Owner.
- F. Records: Nameplate and valve designation data shall be recorded on record drawings and on itemized listing by equipment types and valve number sequence. Itemized listings shall include designation, device description and device location.

3.16 WARNING SIGNS AND OPERATIONAL TAGS:

- A. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of mechanical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.
- B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of mechanical systems, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING".

3.17 EQUIPMENT CONNECTIONS:

- A. Alignment: All piping connecting to pumps and other equipment shall be installed without strain at the piping connection. The Contractor may be required as directed to remove the bolts in these flanged connections or disconnect piping to demonstrate that piping has been so connected.
- B. Connections Different From Those Shown: Where equipment requiring different arrangement or connections from those shown is approved, it shall be the responsibility of the Contractor to install the equipment to operate properly and in harmony with the intent of the Drawings and Specification. When directed by the Architect/Engineer, the Contractor shall submit drawings showing the proposed installation.
- C. Equipment Guards: Provide easily removable expanded metal guards for all belts, couplings, exposed fan inlets and outlets and other moving parts of machinery. Provide access holes to motor and fan shafts on all belt drive and variable speed equipment.
- D. Supports: The Contractor shall support plumb, rigid and true to line all work and equipment furnished under his division. The Contractor shall study thoroughly all Architectural, Structural, Mechanical and Electrical drawings, shop drawings and catalog data to determine how equipment is to be supported, mounted or suspended, and shall provide all bolts, inserts, pipe stands, brackets and accessories for proper support

3.18 ROTATING SHAFTS:

- A. General: Shafts for rotating equipment, such as fans, shall be designed, sized, and fabricated so the shaft will not pass through the first critical speed when accelerating from rest to normal operating speed. This provision shall include the effect of the driven equipment, such as fan blades and related appurtenances, that may influence performance.

3.19 BELT AND COUPLING GUARDS:

- A. General: Provide metal belt guards for all belt-driven equipment. Construct guards sufficiently rigid to provide the required protection and be noise free when the equipment is in operation. Provide coupling guards for all flexible couplings. Coupling guards and belt guards may be perforated metal to allow visual inspection. Belt guards shall have openings to allow measurement of pulley rpm without removal of the guard.
- B. Belt Drives: Belt Drives have been selected as accurately as possible under design conditions. Whenever, in the course of balancing a system, it is determined that a drive change is required, the Contractor shall furnish one completed drive change without additional cost to the Owner or Architect/ Engineer. Multiple belt drives shall have matched belt sets.

3.20 BEARINGS:

- A. General: All ball bearings shall be of radial and/or thrust type, and enclosed in a dust and moistureproof housing. All bearings shall be B-10 minimum life 100,000 hour type selected in accordance with AFBM ratings and arranged for lubrication through Alemite fittings. Bearings shall be standard cataloged items and replacement shall be locally stocked.

3.21 EQUIPMENT HOUSEKEEPING PADS AND ANCHOR BOLTS:

- A. Concrete pads for equipment (housekeeping pads) will be furnished under **this** Division. Pads shall be provided in locations where floor mounted equipment is to be installed.
- B. Pads shall be nominal 3-1/2" high and shall extend a minimum of 3" beyond all equipment and supports while generally conforming to the shape of the equipment. Provide pad heights to match existing pads where located in the same room.
- C. Pads shall be minimum 2500 psi (28 day) concrete reinforced with No. 6 - 6" x 6" welded wire mesh. Pad tops and sides shall be hard troweled smooth with a 3/4" bull nose on all external corners. Refer to Division 3 for additional requirements.
- D. Furnish galvanized anchor bolts with layout templates for installation in equipment pads. Bolts shall be of the size and quantity recommended by the manufacturer and where vibration isolators are used, they shall be anchor bolted to the equipment pad.

3.22 MISCELLANEOUS CURBS AND SUPPORTS:

- A. General: Where required, curbs and supports shall be of box section design, heavy gauge galvanized steel construction, continuous mitered and welded corner seams, integral base plate, factory installed wood nailer, and shall be insulated with 1-1/2" thick, rigid fiberglass board insulation. Curbs and supports shall be mounted and flashed according to manufacturer's recommendations. Curbs and supports shall be as manufactured by the Pate Company of the style as outlined below or approved equal.
- B. Utility Fan Curbs: Shall be Style PC-1A, 12" high.
- C. Duct Curbs: Where ducts are required to penetrate the roof without passing through an equipment curb, Pate Style PC-1A, 12" high curbs shall be used.
- D. Piping Curbs: Where piping penetrates the roof without passing through an equipment curb, Pate Style PCA-1, 12" high curbs shall be used.
- E. Equipment and Piping Supports: Roof mounted equipment and piping routed across the roof shall be supported using Pate Style ES-1A equipment supports with provisions for securing equipment and piping as required. Equipment curbs shall be 12" high. Piping curb height shall be as required to maintain piping slope.

3.23 DEVICE MOUNTING HEIGHTS:

- A. Refer to architectural drawings to determine whether devices occur in wainscot or cabinet spaces and coordinate mounting heights as required by architectural form. For example, mounting heights of devices occurring in a tile or brick wall should be adjusted so that the device will occur entirely within a single course. However, all devices in a given space shall be mounted at the same height.
- B. In general, unless noted otherwise on Architectural or Mechanical Drawings, mounting heights to device center line shall be as follows **[devices occurring in tile walls shall be shifted, slightly, to allow mounting at the best suitable point in a particular tile]**:
 - 1. Wall mounted thermostats/temperature sensors As shown on the Architectural drawings and in **general, located 6" from room light switches and at the same vertical centerline height as switches**
 - 2. Wall hung lavatories As shown on the Architectural drawings

3.24 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS:

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in-service maintenance of all mechanical, plumbing and fire protection services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.
- B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
- C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, air conditioning ductwork and equipment, and similar items to provide this access and shall reinstall same upon completion of work in the areas affected.
- D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.
- E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner 2 weeks advance notice in order to schedule required outages in accordance with Utilities Department Outage Notification policy.
- F. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.
- G. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling

shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owners representative before demolition begins and determine all materials which the Owner specifically chooses to have salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

- H. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- I. When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.
- J. Service lines and piping to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.
- K. During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, and similar items shall be arranged so as to present minimum hazard or interruption to the occupants of the building.
- L. Certain work during the demolition and alteration phase of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner's Representative at least 72 hours in advance.
- M. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace as required any damaged which might occur as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.
- N. Include in the contract price all rerouting of existing ductwork, piping, air devices, fixtures, and similar items and the reconnecting of existing fixtures and devices as necessitated by field conditions to allow the installation of the new systems. Furnish all temporary ductwork and piping, and similar items as required to maintain service for the existing areas with a minimum of interruption.
- O. All existing air devices materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.

- P. Mechanical equipment and building systems equipment, and similar items which are to remain but which are served by piping that is disturbed by the remodeling work, shall be reconnected in such a manner as to leave it in proper operating condition.
- Q. Existing plumbing fixtures, registers, grilles, and diffusers shown to be removed and indicated to be reused, shall be cleaned, repaired and provided with such new accessories as may be needed for the proper installation in their new locations.
- R. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing air devices, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.
- S. Within the remodeled or alteration areas where existing walls are being removed, all existing fixtures, thermostats, other materials and equipment and their appurtenances shall be removed, where required by the remodel work either shown or specified.
- T. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- U. Equipment, piping or other potential hazards to the working occupants of the building shall not be left overnight outside of the designated working or construction areas.
- V. All existing air handling equipment which is shown as being reused shall have coils cleaned and shall be equipped with new filters by this Contractor.
- W. No portion of the fire protection systems shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owners representative.
- X. Refer to Architectural "Demolition" and "Alteration" plans for actual location of walls, ceilings, and similar items being removed and/or remodeled.

END OF SECTION 23 03 00

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 23 05 93 - TESTING, ADJUSTMENT AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: All new and modified existing HVAC, plumbing and fire protection systems and equipment on this project shall be successfully proof, acceptance and operationally tested and balanced, as applicable prior to acceptance of the project by the Tenant.
- B. Proof and Acceptance Testing: The Division 23 Contractor shall provide proof and acceptance testing of HVAC, plumbing and fire protection systems and equipment during the construction process to verify that systems are installed and function as specified. Piping systems shall not be insulated, covered up, or placed in service until piping has been successfully tested, flushed, cleaned and water-treated, as applicable. Ductwork shall not be externally insulated, covered up or placed in service until it has been successfully tested. Equipment shall not be placed in service until it has been checked out, tested and adjusted, as applicable. The Division 23 Contractor shall provide all required proof and acceptance testing, as specified hereinbelow.
- C. System Adjustments/Operational Certification: The Division 23 Contractor shall provide required system adjustments and certify that each HVAC, plumbing and fire protection system is operational, as specified hereinbelow.
- D. Operational Testing and Balancing: All new and modified existing HVAC air, water and control systems on the project shall be operationally tested and balanced prior to acceptance by the Owner. Systems shall be made operational and prepared for operational testing and balancing by the Division 23 Contractor. Operational testing and balancing is specified in Section 23 05 94 and shall be provided by an independent Testing and Balancing (TAB) Consultant who shall be contracted directly to and paid by the General Contractor. The Division 23 Contractor shall provide coordination with and preparations for the TAB Consultant's operational testing and balancing work as specified hereinbelow.
- E. Project Completion: The Division 23 contractor shall provide project completion services as specified hereinbelow.

1.3 QUALITY ASSURANCE:

- A. References: Comply with applicable requirements and recommendations of the following:
 - 1. AABC - 1989 Fifth Edition: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems.
 - 2. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
 - 3. ASHRAE - 1991 HVAC Applications Handbook: Chapter 34, Testing, Adjusting and Balancing.

4. SMACNA - HVAC SYSTEMS Testing, Adjusting and Balancing.

- B. Personnel: Submit evidence to show that the personnel who will actually test systems and equipment are qualified. Evidence showing that the personnel have passed the tests required by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB) will be sufficient. The Engineer reserves the right to require that the originally approved personnel be replaced with other qualified personnel if, in their opinion, the original personnel are not qualified or are not properly conducting the system testing.

1.4 SUBMITTALS:

- A. Testing Procedures: Submit six copies of all proposed proof and acceptance testing and operational certification procedures to the Engineer for review at least 30 days prior to conducting any testing or certification.
- B. Reporting Forms: Submit four copies of proposed forms to be used in recording test and certification data and results to the Engineer for review at least 30 days prior to conducting any testing on the project. Data forms from AABC or NEBB will be acceptable.
- C. Test and Certification Data and Results: Submit six copies of complete data and certified test results for each test performed, including, but not limited to:
1. Title Page: Provide the following information on a title page:
 - a. Title
 - b. System(s) tested
 - c. Testing Company Name
 - d. Testing Company Address
 - e. Testing Company Telephone Number
 - f. Testing Company Contact Person
 - g. Project Name
 - h. Project Location
 - i. Project Architect
 - j. Project Engineer
 - k. Project General Contractor
 - l. Other pertinent information
 2. Instrument List: Provide the following information on an instrument listing page:
 - a. Instruments
 - b. Manufacturers
 - c. Models
 - d. Serial Numbers
 - e. Ranges
 - f. Calibration Dates
 3. Test/Certification Data and Results: Provide pages with applicable test and certification data and results including, but not limited to the following:
 - a. Test/certification performed.
 - b. Test/certification procedure.
 - c. System and area tested.
 - d. Date(s) and time(s) of test.

- e. Weather conditions.
 - f. Test/certification criteria.
 - g. Test/certification results.
 - h. Additional pertinent information.
- D. Operational Certification: Submit six certified copies of an operational certification which documents that all equipment and systems have been fully tested to verify proper operation in accordance with the design shown in the Construction Documents and manufacturer's recommendations.
- E. Certification of TAB Preparations: The Division 23 Contractor shall certify in writing to the Engineer and TAB consultant, by system and area, when coordination is completed and systems have been fully proof/acceptance tested and are operational and prepared for acceptance testing and balancing by the TAB consultant.
- F. Certification: Certifications stating that submitted data is true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.
- G. Calibration List: Submit four copies of a listing of testing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly calibrated.
- H. Test/Certification Log: The Contractor shall maintain a test/certification log at the site to document the results of all successful and unsuccessful testing/certification as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer prior to the Substantial Completion inspection. A space shall be provided on the test/certification log for signoff by the OR/Engineer.
- I. Operating and Maintenance Manuals: Approved copies of Testing Procedures, Test and Certification Data and Results, Operational Certification and Test/Certification Log shall be included in the Operating and Maintenance Manuals specified in Section 23 01 00
- 1.5 NOTICE:
- A. General: Notify the Engineer in writing two weeks prior to all scheduled testing and certification to allow time for Engineer to schedule witnessing of testing and certification, where elected by the Engineer.

PART 2 - PRODUCTS

2.1 TESTING MATERIALS:

- A. General: Provide all materials, equipment and personnel for all required proof and acceptance testing and preparation for operational testing and balancing, including all required retesting and reparation.
- B. Products: Tested products which fail to provide acceptable test results shall be repaired or replaced with suitable materials and then retested until acceptable test results are obtained.

PART 3 - EXECUTION

3.1 PROOF AND ACCEPTANCE TESTING:

- A. General: Proof and acceptance tests shall be made during the course of construction as specified hereinbelow and in other Sections of this Division and as required by Fire Marshall. Such tests shall be conducted by this Division as a part of the Work and shall include all provisions, personnel, material and equipment required to perform tests until satisfactory results are obtained. Any defects detected during testing shall be satisfactorily repaired or the equipment involved shall be replaced and the tests re-executed.
- B. Tests: Testing shall include, but not be limited to, all items listed in other Sections of this Division, and the following:
1. Hydrostatic Testing: All pressurized piping shall be hydrostatically leak-tested prior to enclosure or cover-up. Piping shall be leak tested for 24 hours under a hydrostatic pressure of 150% of the system design working pressure, but not less than 225 psi. The Engineer shall be notified prior to all hydrostatic tests and may elect to witness any of the tests. Water shall not be drawn off of the piping and the piping shall not be covered up until it has been approved by the Engineer. Care shall be taken to protect any equipment which may be damaged by hydrostatic testing. Refer to Sections 22 10 00 and 23 03 00 for additional test requirements. Following successful testing, domestic water piping shall be sterilized and condenser water shall be flushed.
 2. Leak Testing: All soil, waste and vent piping shall be leak tested by temporarily plugging piping stacks and filling the system to be tested with standing water for 3 hours. Water shall not be drawn off of piping and the piping shall not be covered up until it has been approved by the Engineer or OR. Additional testing shall also be provided as required by the local Plumbing Inspection Department. Submit the proposed test procedure and grouping to the Engineer for review. Refer to Section 22 10 00 and 23 03 00 for addition test requirements.
 3. Fire Protection System Hydrostatic Testing: All fire protection piping shall be hydrostatically tested as specified herein above and additional tests shall be performed as Specified in Sections 21 12 00 and 21 13 13.
 4. Fire/Smoke Damper Testing: Provide fire, smoke and fire/smoke damper testing and certification as specified in Section 23 31 14.
 5. Fire Alarm System Interface: Provide testing, in conjunction with the Fire Alarm System functional testing specified in Division 26, to verify that all fire alarm related HVAC control functions and shutdowns operate as specified in Section 23 06 00, Division 26/28 and as shown on the Drawings.
 6. Duct Leakage Testing: Provide duct integrity and leakage testing as specified in Section 23 31 13.
 7. Operational Testing: The Contractor shall test all systems and components installed in the building to verify proper operation is provided as described in the specifications and manufacturer's recommendations.
 8. Emergency Power Operation Testing: Testing of BCAS, HVAC, plumbing and fire protection system operation under emergency power shall be coordinated with the Division 26 Contractor such that the testing is conducted along with the Division 26 emergency power system testing and certification.

9. Sewer Rodding: All modified sanitary and storm sewer piping shall be free of obstructions both inside the building and to the points of connection to public utility systems. If blockage develops in any sanitary or storm piping within the warranty period and the blockage is due to construction related debris or defects, this Contractor shall be responsible for the cost of rodding out the piping to remove the blockage or obstruction. The rodding shall be done at no additional cost to the Owner or Engineer. Notify the Engineer prior to proceeding with rodding of any piping.

C. Authorities Having Jurisdiction: The Division 23 Contractor shall also perform any additional proof and acceptance testing required by all applicable Authorities having jurisdiction over the project.

3.2 SYSTEM ADJUSTMENTS:

A. General: Systems installed under this Division, except HVAC air and water balancing shall be adjusted by the Division 23 Contractor to provide proper operation.

B. Adjustments: Systems to be adjusted shall include, but not be limited to:

1. Miscellaneous Controls and Alarms: Adjust and test all miscellaneous pressure, temperature, flow, level, refrigerant and similar controls and related alarm systems and monitoring to provide proper operation.

2. Control Balancing: All control systems and equipment installed on the project shall be programmed, calibrated and/or adjusted to provide proper operation or function in accordance with the drawings, specifications and manufacturer's recommendations. This programming, calibration and adjusting shall be completed as part of the preparations for air and water system balancing specified hereinbelow.

3.3 OPERATIONAL CERTIFICATION:

A. General: Submit HVAC, plumbing and fire protection systems to operational tests to demonstrate satisfactory system operation.

B. HVAC Systems: Operationally test project HVAC systems to demonstrate satisfactory operation. Operation tests shall include, but not be limited to:

1. Tenant condenser water pump and computer room AC system operation.
2. Results of other HVAC system tests.
3. Test results for all piping system tests.
4. Test results for all ductwork leakage tests.
5. Test results for HVAC system water treatment.
6. Time, date and duration of each test.

C. Plumbing Systems: Operationally test project plumbing systems to demonstrate satisfactory operation. Operational testing shall include, but not be limited to:

1. Water pressure at most remote and highest fixtures.
2. Operation of each fixture and fixture trim.
3. Operation of each valve, hydrant and faucet.
4. Operation of each backflow preventer and vacuum breaker.
5. Operation of each floor and hub drain by flooding with water.
6. Operation of each trap primer.
7. Operation of domestic water heaters and supply/return water temperature at each heater.
8. Results of other required plumbing system tests.

9. Test results for all piping system leakage tests.
10. Test results for disinfection of domestic water system.
11. Time, date and duration of each test.

- D. Fire Protection Systems: Operationally test project fire protection systems to demonstrate satisfactory operation. Operational testing shall include, but not be limited to:
1. Test results for all piping system leakage tests.
 2. Time, date and duration of each test.

3.4 PREPARATION FOR OPERATIONAL TESTING AND BALANCING:

- A. General: All air, water and control systems installed on the project shall be balanced and/or adjusted to provide proper operation or function in accordance with the drawings, specifications and manufacturer's recommendations. Refer to Section 23 05 94 for HVAC air, water and control system operational testing and balancing. System startup and preparation for operational testing and balancing shall be provided under this Section.
- B. Provisions for Operational Testing and Balancing: The Division 23 Contractor shall install all provisions for operational testing and balancing as shown on the drawings, specified and required by the TAB Consultant. These provisions shall include, but not be limited to all control, regulating and readout devices necessary to operationally test and balance all air, water and control systems including, but not limited to: thermometers; pressure gauges; balancing valves; air volume, splitter and extractor dampers; pressure taps; temperature taps and wells; pitot tube ports; and other necessary provisions.
1. The Division 23 Contractor shall notify the Engineer in writing and receive clarification in writing prior to submitting a bid, if in the Contractor's opinion, any required provisions have been omitted. Submission of a bid constitutes an agreement that all provisions required for operational testing and balancing shall be provided at no cost to the Owner or Architect/Engineer, regardless of whether such provisions are specifically shown on the drawings or in the specifications.
- C. Coordination and Scheduling: The Division 23 Contractor shall coordinate and schedule preparations for operational testing and balancing with the TAB Consultant. This coordination and scheduling shall include, but not be limited to:
1. Coordinate exact locations of operational testing and balancing provisions with the TAB Consultant.
 2. Sequence completion of preparation for operational testing and balancing to allow adequate time for the TAB Consultant to complete operational testing and balancing prior to project substantial completion.
- D. TAB Consultant Input: the Division 23 Contractor shall provide input to the TAB Consultant including, but not limited to:
1. All approved HVAC Shop Drawings.
 2. Belt drive data on all belt driven equipment.
 3. As-built drawings accurately showing locations of all measuring and balancing devices, air vents and drain valves.
 4. Control diagrams and sequence of operation.
 5. Copies of all HVAC RFI's and Change Orders.
 6. Additional input required by the TAB Consultant.

- E. TAB Consultant Noted Deficiencies: The Division 23 Contractor shall correct any deficiencies noted to the TAB Consultant during the operational testing and balancing process. Corrections shall be made in a timely manner so as not to impede the work of the TAB Consultant. These corrections shall include, but not be limited to:
1. Relocating test points and sensors/controllers which are installed or positioned in a manner which prevents correct measurement or sensing of temperatures, pressures, humidity, etc. and to provide sufficient access to these devices.
 2. Corrections to control functions which do not operate in accordance with the sequence of operation.
 3. Recalibration of control devices.
 4. Relocation of air and water taps which are installed or positioned in a manner which does not allow design flows to be obtained in the tap.
 5. Relocation of balancing and control devices to provide sufficient access to these devices.
 6. Addition of required balancing dampers and valves.
- F. Preparation for Air Balancing: All modified Base Building and new air systems shall be completely installed, operational and prepared prior to commencing with air balancing. The minimum steps required for preparation for air balancing shall include, but not be limited to:
1. Inspection: Inspect and certify in writing that the complete air system including, but not limited to: air handling equipment, fans, terminal units, coils, ductwork, air devices, dampers, controls, balancing devices, access doors, test ports, return air paths, partitions to deck and doors in partitions to deck are installed and operational, as applicable.
 2. Operation: Certify that the complete air system is operable and operates in a safe and normal manner.
 3. Dampers: Inspect and certify in writing, that all required volume, splitter, extractor, fire, smoke and fire/smoke dampers are installed, that all balancing dampers are in the open and locked position, that all fire dampers are open, that all fire/smoke, smoke and control dampers open and close properly in response to control sequences and that all access doors are closed and sealed.
 4. Controls: Verify in writing that all required air system controls, interlocks and safety devices are fully operational and that all controlling devices are calibrated and set for designed conditions.
 5. Testing: Verify in writing that all specified duct leakage and fire, smoke and fire/smoke damper testing has been successfully completed and that duct systems are clean and free of any dirt or debris.
 6. Cleaning: Install clean air filters in all equipment and, where equipment has been operated, clean coils and vacuum equipment interior in preparation for balancing. Comb out any coiled fins damaged by construction or cleaning. The Engineer and OR shall be the final decision makers on whether coils and equipment must be cleaned prior to balancing.
 7. Notification: Notify the Engineer and TAB Consultant in writing when all items required in paragraphs 3.04B, 3.04C, 3.04D 3.04E and 3.04F/1-8 have been completed for a specific air system and certify that the system is operational and prepared for operational testing and balancing.

3.5 PROJECT COMPLETION:

- A. General: Prior to Project Substantial Completion, the Contractor shall provide project completion services necessary to complete the project including, but not limited to:
1. Completion Reports: After all testing, balancing and adjusting, the Contractor shall furnish all labor, materials and devices necessary to prepare a completion report with the following information.
 - a. Motor data on all motors installed on the project. Motors shall be listed by the device on which they are installed and information provided shall include: horsepower, speed, type, location, rated full load amperage, rated voltage, actual measured amperage for each leg and actual measured voltage for each leg.
 - b. Belt and drive data for all belt driven equipment installed on the project. Data shall be listed by the device on which the belts and drive are installed and information provided shall include: number of belts, size of belts, size and type of drive installed, motor rpm and driven device rpm.
 - c. Fan speed data shall be measured and recorded in rpm, for each belt drive and variable speed fan.

END OF SECTION 23 05 93

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 23 05 94 - TESTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: All modified HVAC air systems and related equipment on this project shall be successfully operationally tested and balanced, as applicable prior to acceptance of the project by the Owner.
- B. Operational Testing and Balancing: All new and modified existing HVAC air systems on the project shall be operationally tested and balanced prior to acceptance by the Tenant. Systems shall be made operational and prepared for operational testing and balancing by the Division 23 Contractor. Operational testing and balancing is specified herein and shall be provided by the UTHealth hired independent Testing and Balancing (TAB) Consultant who shall be contracted directly to and paid by the UTHealth. UTHealth will provide the services of designated Owner's Representatives (OR) who will observe selected operational testing and balancing for the systems installed on the project. The Division 23 Contractor shall provide coordination with and preparations for the TAB Consultant's operational testing and balancing work as specified in Section 23 05 93.
- C. Follow-up Services: The TAB Consultant shall provide the following follow-up services related to operational testing and balancing, as a minimum:
 - 1. Provide three follow-up inspections within 90 days of occupancy for temperature verification. Make any required corrections and adjustments and submit documentation of findings and associated correction and adjustments made to the Owner's Representative and the Engineer.
 - 2. After operational testing and balancing has been completed and accepted by the Owner and Engineer, the TAB Consultant shall return at the following season change to test, adjust and resubmit a complete balance report and obtain the Owner's Representative's approval of the second report. The second system balance shall occur during the project warranty period and shall be scheduled by the Owner's Representative.
- D. Coordination: The TAB Consultant shall cooperate and coordinate their work with the General Contractor and Division 23 and 26 Subcontractors who shall provide assistance.

1.3 QUALITY ASSURANCE:

- A. Supervision: All operational testing and balancing work shall be performed under the supervision of an AABC or NEBB certified Test and Balance Engineer.
- B. References: Comply with applicable requirements and recommendations of the following:
 - 1. AABC - 1989 Fifth Edition: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems.
 - 2. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
 - 3. ASHRAE - 1991 HVAC Applications Handbook: Chapter 34, Testing, Adjusting and Balancing.
- C. Personnel: Submit evidence to show that the personnel who will actually test systems and equipment are qualified. Evidence showing that the personnel have passed the tests required by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB) will be sufficient. The Engineer reserves the right to require that the originally approved personnel be replaced with

other qualified personnel if, in their opinion, the original personnel are not qualified or are not properly conducting the operational testing and balancing.

1.4 SUBMITTALS:

- A. Testing and Balancing Procedures: Submit four copies of all proposed operational testing and balancing procedures to the Engineer for review at least 30 days prior to conducting any testing or balancing.
- B. Reporting Forms: Submit four copies of proposed forms to be used in recording operational testing and balancing data and results to the Engineer for review at least 30 days prior to conducting any testing or balancing on the project. Data forms from AABC, NEBB or SMACNA will be acceptable.
- C. Operational Testing and Balancing Data and Results: Submit six copies of complete operational test and balance data and certified balance results for each system balanced, including, but not limited to:
 - 1. Title Page: Provide the following information on a title page.
 - a. Title
 - b. System(s) operationally tested and balanced
 - c. TAB Consultant Name
 - d. TAB Consultant Address
 - e. TAB Consultant Telephone Number
 - f. TAB Consultant Contact Person
 - g. Project Name
 - h. Project Location
 - i. Project Architect
 - j. Project Engineer
 - k. Project General Contractor
 - l. Other pertinent information
 - 2. Instrument List: Provide the following information on an instrument listing page.
 - a. Instruments
 - b. Manufacturers
 - c. Models
 - d. Serial Numbers
 - e. Ranges
 - f. Calibration Dates
 - 3. Operational Test/Balance Data and Results: Provide pages with applicable operational testing and balancing data and results including, but not limited to the following.
 - a. Operational test/balance performed
 - b. Operational test/balance procedure
 - c. System and area tested
 - d. Date(s) and time(s) of test
 - e. Weather conditions

- f. Project altitude
 - g. Operational test/balance criteria
 - h. Additional pertinent information
4. HVAC Terminal Unit Data: Provide pages with applicable HVAC terminal unit data including, but not limited to the following:
- a. Identification/location
 - b. Manufacturer
 - c. Model/type
 - d. Design primary air flow
 - e. Actual primary air flow
 - f. Inlet pressure
 - g. Outlet pressure
 - h. Fan speed
5. Fan Data: Provide pages with applicable fan data including, but not limited to the following:
- a. Identification/location
 - b. Manufacturer
 - c. Model/type
 - d. Design air flow
 - e. Actual air flow
 - f. Design total static pressure (total external)
 - g. Actual total static pressure (total external)
 - h. Inlet pressure
 - i. Discharge pressure
 - j. Fan RPM
6. Electric Motor Data: Provide pages with applicable motor data including, but not limited to the following:
- a. Manufacturer
 - b. HP/BHP
 - c. Type
 - d. Phase and voltage and amperage (nameplate, actual and no load) for each phase
 - e. RPM (nameplate and actual)
 - f. Service factor
 - g. Starter size, rating, heater elements
7. Return Air/Outside Air Data: Provide pages with applicable return air/outside air data including, but not limited to the following:
- a. Identification/location
 - b. Design air flow

- c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
8. V-Belt Drive Data: Provide pages with applicable V-belt drive data including, but not limited to the following:
- a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave, diameter and RPM
 - f. Center-to-center distance (maximum, minimum and actual)
9. Duct Traverse Data: Provide pages with applicable duct traverse data including, but not limited to the following:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
10. Air Distribution Device Flow Data Sheets: Provide pages with applicable air distribution device flow data including, but not limited to the following:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size

- e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
11. **Additional Data Sheets:** Provide pages with additional data and information as required to present all data and information associated with the operational testing and balancing process.
- D. **Certification:** Certifications stating that submitted data is true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.
- E. **Calibration List:** Submit four copies of a listing of testing and balancing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly calibrated.
- F. **Operational Testing/Balancing Log:** The Contractor shall maintain a test/balancing log at the site to document the results of all successful and unsuccessful testing/balancing as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer prior to the Substantial Completion inspection. A space shall be provided on the testing/balancing log for signoff by the OR/Engineer.
- G. **Operating and Maintenance Manuals:** Approved copies of Testing Procedures, Operational Testing and Balancing Data and Results and the Operational Testing/Balancing Log shall be included in the Operating and Maintenance Manuals specified in Section 23 01 00.
- 1.5 **NOTICE:**
- A. **General:** Notify the Engineer in writing two weeks prior to all scheduled operational testing and balancing to allow time for Engineer to schedule witnessing of operational testing and balancing, where elected by the Engineer.

PART 2 - PRODUCTS

2.1 TESTING MATERIALS:

- A. **General:** Provide all materials, equipment and personnel for all required operational testing and balancing, including all required retesting and rebalancing.
- B. **Products:** Installed products which fail to provide acceptable balance results shall be repaired or replaced with suitable materials by the installing contractor and then rebalanced until acceptable test results are obtained.

PART 3 - EXECUTION

3.1 GENERAL:

- A. **Provisions for Balancing:** Fully examine the Drawings and Specifications for this project and determine whether or not sufficient volume dampers, balancing valves, thermometers, gauges, pressure and temperature taps, means of reading static and total pressure in duct systems, means of determining water flow, and other means of taking data needed for proper testing and balancing are shown or specified. If, in the opinion of the Testing and Balancing Consultant, any required items have been omitted, notify the Engineer in writing and receive clarification before submitting a proposal for

this project. Tender of a proposal conveys full agreement of the system as designed provides provisions for proper balancing.

- B. Preparation for Operational Testing and Balancing: The Division 23 Contractor shall install all systems, make them operational and prepare them for operational testing and balancing as specified in Section 23 01 00. The TAB Consultant shall coordinate these preparations with the Division 23 Contractor including, but not limited to:
1. Coordinate exact locations of operational testing and balancing provisions with the TAB Consultant.
 2. Sequence completion of preparation for operational testing and balancing to allow adequate time for the TAB Consultant to complete operational testing and balancing prior to project substantial completion.
- C. TAB Consultant Input: The Division 23 Contractor shall provide input to the TAB Consultant including, but not limited to:
1. All approved HVAC and BCAS Shop Drawings.
 2. Belt drive data on all belt driven equipment.
 3. As-built drawings accurately showing locations of all measuring and balancing devices, air vents and drain valves.
 4. Copies of all HVAC and BCAS RFI's and Change Orders.
 5. Additional input required by the TAB Consultant.
- D. TAB Consultant Noted Deficiencies: The Division 23 Contractor shall correct any deficiencies noted to the TAB Consultant during the operational testing and balancing process. Corrections shall be made in a timely manner so as not to impede the work of the TAB Consultant. These corrections shall include, but not be limited to:
1. Relocating test points and sensors/controllers which are installed or positioned in a manner which prevents correct measurement or sensing of temperatures, pressures, humidity, etc. and to provide sufficient access to these devices.
 2. Corrections to control functions which do not operate in accordance with the sequence of operation.
 3. Recalibration of control devices.
 4. Relocation of air and water taps which are installed or positioned in a manner which does not allow design flows to be obtained in the tap.
 5. Relocation of balancing and control devices to provide sufficient access to these devices.
 6. Addition of balancing dampers and valves.
- E. Scheduling: The TAB Consultant shall schedule their work so as to smoothly coordinate with the work of the General Contractors and Subcontractors and to minimize impact on completion and occupancy of the building.
- 3.2 AIR BALANCE:
- A. General: When preparations for air balancing have been completed and signed off by the Division 23 Contractor, verify that preparations have been completed and perform an air balance on all new and modified existing air systems in accordance with applicable AABC or NEBB Standards and record the results on applicable forms. The supply, return, outside air and exhaust volume to/from each piece of equipment, through each volume damper and through each air device shall be adjusted to within $\pm 5\%$ of the values shown on the Drawings and or scheduled. The minimum scope required for air balancing shall include, but not be limited to:

1. Shop Drawings: Obtain copies of shop Drawings and manufacturer's data for all equipment, dampers and air devices and temperature control diagrams.
2. Report Forms: Prepare report test sheets for each item of equipment, damper and air device type with appropriate data entry points, manufacturer's data and recommended test procedure.
3. Diversity: Develop a procedure to simulate diversity, if applicable on VAV air systems. The proposed procedure shall be approved by the Engineer.
4. VAV System Curves: Construct approximate system curves, including surge areas, for all VAV fans. Each system curve should start at the HVAC terminal unit minimum inlet static pressure plus the duct system pressure drop at minimum flow and terminate at the system design maximum flow.
5. Constant Volume Air Handling Units: Measure and adjust supply, return and outside air volumes for unit, as applicable. Verify proper operation and adjust the unit temperature controls to provide scheduled space/discharge temperatures. Verify proper operation of unit stop/start controls, monitoring, safeties, temperature controls and associated automatic dampers.
6. HVAC Terminal Units: Measure and adjust unit maximum and minimum cooling air volumes and fan supply volumes (fan powered terminal units only). Verify proper operation of unit start/stop controls, monitoring and temperature controls.
7. Fans: Measure and adjust fan volumes to provide volume required to provide scheduled volumes at served systems, equipment and/or air devices. Verify proper operation of unit start/stop controls, monitoring, safeties and associated automatic dampers.
8. Fan Coil Units: Measure and adjust supply, return and outside air volumes for unit, as applicable. Verify proper operation of unit stop/start controls, monitoring, safeties, temperature controls and associated automatic dampers.
9. Ductwork: Verify that ductwork leakage is not excessive by comparing equipment duct traverse readings to air device and served equipment duct traverse readings.
10. Volume Dampers: Clearly and permanently mark the balanced position and balance date on all volume dampers.
11. Air Devices: Measure and adjust each air return or exhaust inlet and supply diffuser, register and grill to within $\pm 5\%$ of design air cfm. Dampers in diffusers, if provided, may be used for only 10% adjustment from full air flow.
12. Control Devices: Verify operation and adjustment of all control devices.
13. Balancing Methods: Air handling unit and fan volumes shall be adjusted by changing fan speed. Branch duct and multi-zone unit zone volumes shall be balanced at duct volume dampers. Air device volumes shall be adjusted using spin-in/tap dampers. Where opposed-blade dampers (OBD's) are scheduled or specified, these dampers shall be used for final balancing only and shall be throttled a maximum of 10% closed.
14. Volume Measurements:
 - a. Ampere Readings: Measure and record full load amperes for motors.
 - b. Static Pressures: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be graphically compared to the specific fan curve. Static pressures shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.

- c. Equipment Airflow: Measure and record exhaust, return, outside and supply air cfm(s) and temperatures, as applicable, at each fan, blower and coil.
- d. Zone Airflow: Measure and record airflow for each zone of multi-zone units , each HVAC terminal unit and each air handling unit for design cfm.
- e. Outlet Airflow: Measure and record air volume for each air return or exhaust inlet and supply diffuser, register and grille. Measure discharge temperature from the most remote supply air device served by each air handling unit, fan coil unit and terminal unit and record along with the serving equipment discharge air temperature and calculated duct heat gain delta T. Include all terminal points of air supply, all points of exhaust and all points of return air.
- f. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of traverse measurements shall be clearly described on the sheet containing the data.
- g. Zone Control: Measure and record the control air pressure at minimum and maximum cooling, calibration point, full bypass, and minimum and maximum heating when applicable.
- h. Cold Deck Control: Measure and record the control pressure output and air temperature with minimum cold deck airflow and maximum cold deck airflow.
- i. Single Zone Air Handling Units: Measure and record control pressure at maximum and minimum cooling, and maximum and minimum heating. Verify operation of all auxiliary controls such as outside air dampers and firestats.

END OF SECTION 23 05 94

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 23 07 00 - SYSTEM INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.
- B. Refer to Section 23 31 13, "Ductwork", for duct lining requirements and Section 23 37 13, "Air Distribution Devices", for additional insulation requirements.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide piping, ductwork and equipment system insulation as specified.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Armstrong World Industries.
 - 2. Certain-teed Corporation.
 - 3. Rubatex LLC
 - 4. Resolco Insul-phen
 - 5. Schuller.
 - 6. Owens/Corning Fiberglass.
 - 7. Pittsburgh Corning.

1.4 SUBMITTALS:

- A. Shop Drawings submittals shall include, but not be limited to, the following:
 - 1. Cut sheets on all insulation products to be used.
 - 2. Cut sheets on all mastics and other products to be used with insulation products.
 - 3. Manufacturer's printed installation instructions for all of the above products.
 - 4. Additional information as required in Section 23 00 01, "Mechanical General Provisions".

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Store insulation products in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Quality: The type of insulation and its installation in accordance with this Section of the Specifications for each service and the application technique shall be as recommended by the manufacturer.
- B. Fire Rating: All insulation shall have a composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard, as tested by ASTM E84, NFPA 255, and UL 723, not to exceed:
 - 1. Flame Spread 25.
 - 2. Smoke Developed 50.
- C. Accessories: Accessories such as adhesives, mastics, tapes, and cements shall have the same component ratings as listed.
- D. Labels: Label products and their shipping cartons indicating that flame spread and smoke developed ratings do not exceed the above requirements.

2.2 INSULATION THICKNESS:

- A. Minimum: Insulation thickness shall not be less than the following:

Ductwork Surface

Conditioned air ductwork, external wrap (where not lined)	1-1/2"
Ductwork, acoustical lining (see Section 23 31 13).	

2.3 DUCTWORK:

- A. External Ductwork Insulation: Provide Schuller "Microlite" R-Series or an approved equal **2"** thick flexible fiberglass duct wrap with fiberglass reinforced kraft-scrim-foil vapor barrier jacket. Ductwrap shall have a density of 0.75 pounds per cubic foot, K factor of 0.31 at 75° F and a permeability of 0.04 perm. Insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.
- B. Acoustical Duct Lining: Lining provided with ductwork, refer to Section 23 31 13.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install insulation products in accordance with the manufacturer's written instructions, the Midwest Insulation Contractors Association (MICA) Commercial and Industrial Insulation Standards, and recognized industry practices to ensure that the insulation serves the intended purpose. Surfaces to be insulated shall be thoroughly cleaned with all testing successfully completed prior to insulation.

3.2 DUCTWORK APPLICATION:

- A. Exterior Ductwrap Insulation On Supply and General Exhaust Ductwork: After ductwork testing has been completed, insulate Supply ductwork as specified in section 2.5 above. On ducts over 18" wide, apply weld clips to bottom of duct, spaced 18" on center each way,

maximum. Seal all longitudinal and transverse seams and all punctures caused by weld clips or stick clips with 2" wide SMACNA-labeled duct tape and mastic.

- B. Acoustical Duct Lining For Supply, Return and General Exhaust Ductwork: Refer to Section 22 31 13 for additional information.
- C. Rigid Ductwork Insulation: After duct testing has been completed, install rigid external duct insulation where shown on the drawings. Insulation shall be secured to the ductwork with mechanical fasteners, "stick clips", Graham Pins or Speed Clips spaced on maximum 12" centers on the bottom of the duct and maximum 24" centers on the top and side of the duct. Additional fasteners shall be provided as recommended by the insulation manufacturer or required to hold insulation securely against the duct. After the insulation is in place, all joints, seams and protrusions through the duct shall be thoroughly sealed with Foster 30-35 or approved equal white vapor barrier emulsion applied over 3" wide Duramesh Glass Fabric or approved equal glass fabric strips. Where ductwork has standing seams or external angle bracing, insulation shall be built up over protrusions and sealed as described hereinabove.
- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles, cements adhesives, coatings, sealers, protective finishes, and similar compounds as recommended by the insulation manufacturer for the applications indicated.
- E. Air Devices: Insulate all air devices not factory-insulated with fiberglass ductwrap where diffusers are located in ceilings that are not used as return air plenums.
- F. Surfaces: Install insulation materials with smooth, even surfaces.
- G. Butt Joints: Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- H. Vapor Barrier: Maintain integrity of vapor barrier on ductwrap insulation and protect barrier to prevent puncture and other damage.
- I. Penetrations: Extend ductwrap insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.
- J. Corner Angles: Install corner angles on external corners of insulation on ductwrap in exposed finished spaces before covering with jacketing.

3.3 INSPECTION:

- A. General: Visually inspect the completed insulation installation and repair or replace any improperly sealed joints.
- B. Wet Insulation: Where there is evidence of vapor barrier failure or "wet" insulation after installation, the damaged insulation shall be removed, the pipe or duct surface shall be cleaned and dried and new insulation shall be installed.

3.4 IDENTIFICATION:

- A. Refer to Section 23 03 00 for applicable painting and labeling requirements.

END OF SECTION 23 07 00

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

This Page is Intentionally Blank

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide metal ductwork systems as shown on the Drawings and as specified herein.
- B. System Types: The types of ductwork systems specified in this Section include, but are not necessarily limited to the following:
 - 1. Air conditioning supply and return air systems.
- C. Constant Volume Supply Air Ductwork: Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to +2" wg. Ductwork shall be externally insulated.
- D. Return Air Ductwork: Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to -1" wg. Ductwork used for return air boots and elbows and other return air ductwork where shown on the Drawings shall be lined with one inch (1") ductliner.
- E. Flexible Ductwork: Ductwork connections to HVAC terminal units and air devices shall be made with flexible ductwork connection where shown on the Drawings. Additional connections may be made using flexible ductwork at the Contractors option, where approved in writing, in advance, by the Engineer.
- F. Ductwrap Insulation: Refer to Section 23 07 00, "System Insulation", for external ductwrap insulation.
- G. Ductwork Accessories: Refer to Section 23 31 14, "Ductwork Accessories", for accessories and specialties related to ductwork systems and installation.
- H. Basic Materials and Methods: Refer to Section 23 03 00, "Basic Materials and Methods", for basic materials and methods related to mechanical construction.

1.3 QUALITY ASSURANCE:

- A. SMACNA Standards: Comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA), HVAC Duct Construction Standards, Metal and Flexible, 1985 Edition recommendations for fabrication, construction, details, and installation procedures, except as otherwise indicated on the Drawings or in these Specifications.
- B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards and recommendations, except as otherwise indicated on the Drawings or in these Specifications.

1.4 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
1. Ductwork submittals shall include ductwork fabrication drawings and submittal data on ductwork specialties and construction details.
 2. Ductwork fabrication drawings shall be drawings to scale on 1/4" scale building floor plans and shall indicate duct sizes, duct material, duct insulation type, locations of transverse joints, fittings, ductwork bottom elevation, offsets, ductwork specialties, flexible connections, flexible ductwork, fire and fire/smoke dampers and all other information required for coordination with other trades and fabrication of ductwork. All fire and fire/smoke partitions shall be clearly designated on the ductwork shop drawings. Ductwork fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval.
 3. Duct specialties and construction details including, but not limited to information on duct construction and materials, transverse and longitudinal joints, cross-breaking or transverse beading, dampers, flexible connectors, fittings, transitions, elbows, control, fire and fire/smoke damper connections, branch taps, turning vanes, access doors and other required duct specialties and construction details.
 4. Cut sheets on flexible ductwork and related taps and accessories.
 5. Cut sheets on breeching and flue piping materials and accessories, including a complete flue design layout.
 6. Duct system leakage test procedures and reporting forms.
 7. Additional information as required in Section 23 00 01, "Mechanical General Provisions.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver ductwork materials to the site in suitable packaging to prevent damage and exposure to weather.
- B. Store ductwork in dry areas, where it is not exposed to damage. Crib stored ductwork off of floors to prevent water damage.
- C. Handle ductwork to prevent damage.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS:

- A. Sheet Metal: Ductwork shall be constructed using prime G90 galvanized lock-forming quality or coil steel in widths up to 60", conforming to ASTM A924/A924M-74, A653 and A653M, UMC requirements and using gauges selected by application, based upon applicable SMACNA Standards.
- B. Labeling: Ductwork materials shall be stenciled on maximum 10'centers with the manufacturer's name and material gauge. Stenciling shall be visible after duct is fabricated and installed.
- C. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam

marks, roller marks, oil canning, stains, discolorations, and other imperfections, including those which would impair painting.

2.2 MISCELLANEOUS DUCTWORK MATERIALS:

- A. General: Provide miscellaneous materials and products of the types and sizes indicated and where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Duct Sealant: Provide non-hardening, non-migrating mastic or liquid elastic sealant (type applicable for the fabrication/installation detail) as compounded and recommended by the manufacturer specifically for sealing joints and seams in ductwork. Sealers shall be as follows:
 - 1. Sealer shall have a high solids content.
 - 2. Sealer shall have a high adhesive and cohesive strength and shall bond to both degreased and non-degreased metals.
 - 3. Sealer shall conform to NFPA 90-A requirements and be UL-labeled for ductwork applications.
 - 4. Sealer and related installation materials and methods shall be:
 - a. Hardcast Type 601 Iron Grip Duct Sealant.
 - b. United McGill Corporation United Duct Sealer.
 - c. Foster Type 30-02 High Velocity Duct Seal.
 - d. Transcontinental Equipment Ltd. Multipurpose Water Based Duct Sealer.
- C. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim, and angles for support of ductwork.
- D. Exposed Stainless Steel: Provide matching stainless steel supports for exposed stainless steel ductwork.

2.3 DUCTLINER:

- A. Acoustical Ductliner: Provide Schuller Permacote Linacoustic Standard/HP or Owens-Corning Aeroflex 1" thick fiberglass ductliner with an NCR of 0.70 or greater per ASTM C1071, a thermal conductivity of 0.31 BTU in/(hr ft² °F) and friction correction factor no greater than 1.02 at 500 fpm. All ductliner shall be guaranteed against delamination up to 3000 fpm velocities. Ductliner shall have a surface coating formulated with an immobilized, EPA-registered, anti-microbial agent so it will not support the growth of fungus or bacteria.
- B. Ductliner Adhesive: Provide non-flammable adhesives 3M #37, St. Clair R41B, Foster 85-11 or Foster 85-20, which comply with NFPA 90A and ASC-A-7001 by The Adhesive and Sealant Council, Inc. (see SMACNA standards).
- C. Ductliner Fasteners: Comply with SMACNA requirements.

2.4 FLEXIBLE DUCT:

- A. General: Insulated flexible duct shall be a factory fabricated assembly consisting of an inner liner, fiberglass insulation and a vapor barrier outer jacket.

- B. Inner Liner: The inner liner shall consist of a galvanized steel helix mechanically securing an inner liner composed of a tri-laminate of aluminum foil, fiberglass and aluminized polyester for applications upstream of HVAC terminal units and shall consist of a galvanized steel helix mechanically securing an inner liner composed of a SPUNBOND nylon fabric for applications downstream of HVAC terminal units.
- C. Insulation: Duct liner shall be wrapped with a nominal one inch (1") thick fiberglass insulation blanket with a maximum thermal conductance C Factor of 0.23 Btu/hr/sf/°F.
- D. Outer Jacket: Insulation shall be covered with a reinforced metalized aluminum vapor barrier jacket with a maximum permeability of 0.05 Perm per ASTM E96, Procedure A.
- E. Pressure Ratings: Flexible duct for applications upstream of HVAC terminal units shall be rated for a minimum of 12" positive and 5" negative internal working pressure. Flexible duct for air device applications shall be rated for 6" positive and 4" negative internal working pressure. Flexible duct shall be suitable for operation at temperatures up to 120°F.
- F. Sound Attenuation: Flexible duct for air device applications shall be designed to provide sound attenuation and a 9' length of 8" duct shall have typical insertion losses (IL), in dB, as follows:

<u>Octave Band</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
Straight Duct at 2500 fpm flow		9	27	27	32	33
90° Bend Duct at 2500 fpm flow		18	31	34	37	38

- G. Codes/Standards: Flexible duct shall be listed as Class 1 Air Duct per UL 181 and shall comply with NFPA 90A and 90B.
- H. Fire Ratings: Flexible duct shall have a flame spread rating of less than 25 and a smoke developed rating of less than 50.
- I. Clamps: Terminal unit flexible duct inner liner shall be secured using Flexmaster LS Series or approved equal 1/2" wide positive locking stainless steel straps. Air device flexible duct outer jackets shall be secured using Panduit Corporation, Ideal or an approved equal 0.35" wide self-locking nylon straps.
- J. Air Device Flexible Duct Taps: All round take-offs for air devices shall be made with a damper spin-collar, equal to a Flexmaster FLD dampered spin fitting. Where the duct height does not allow the use of a spin-in fitting, use 45° STOD side take offs with dampers, equal to Flexmaster 45° STOD STOD Fittings. Dampers shall be provided with full length 3/8" square shafts secured to the damper blade with a minimum of 2 U-bolts, nylon bearings, insulation build out, heavy duty locking hand quadrants and integral flexible duct retention beads. Fittings and damper blades shall be minimum 26 ga. galvanized sheetmetal for sizes up to 10" and minimum 24 ga. galvanized sheetmetal for sizes up 12" and larger.
- K. Manufacturers: Flexible duct for air device applications shall be Flexmaster Type 6M Acoustical or an approved equal.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

- A. Standards: Round and rectangular sheet metal ductwork shall be constructed in accordance with SMACNA "HVAC Duct Constructions Standards", 1985 Edition, ASHRAE Guide and Data Book, "Handbook of Fundamentals", latest edition, specifically Chapter 25 and NFPA

Standard 90-A, "Standard for the Installation of Air Conditioning and Ventilating Systems". Duct sizes shown are clear inside dimensions. Where ductliner is specified, increase each dimension to accommodate liner.

- B. Route all duct tight to underside of structure, unless otherwise noted or required for coordination. All ductwork shall be top level with bottom and side transitions only. The Mechanical Contractor shall be held responsible for coordinating with all other trades prior to the construction or installation of ductwork. Some ductwork may require the use of S-drive joints, flat seams or offsets to allow installation of other ducts or equipment. Use 45 degree radius elbows (center line radius 1.5 times duct height) to rise up and drop down when crossing ductwork or other material. The Mechanical Contractor shall be responsible for coordination of all such work with the General Contractor and other Subcontractors as required. Minimum bottom of duct elevation above finished floor shall be as noted on the Drawings, where applicable.
- C. Adhere to the Drawings for routing and location of ductwork as closely as possible. Ductwork shop drawings shall be made after job site measurements are made and shall be coordinated with all other trade. Ductwork construction details and materials shall be submitted and approved prior to fabrication of any ductwork.
- D. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Engineer.
- E. The interior surface of all ductwork shall be smooth with no parts projecting into the air stream unless specified to do so. All seams and joints shall be external. The inside of all ductwork shall be thoroughly cleaned and all fans operated to remove any debris prior to connection of air devices.
- F. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.
- G. Where ducts, exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.
- H. When the Mechanical Contractor submits revised duct sizes for review by the Engineer or requests to substitute rectangular, round or flat oval duct sizes for rectangular, round or flat oval spiral duct, substitute sizes shall be based on equivalent hydraulic diameter as calculated by ASHRAE formulae for equivalent friction loss and airflow.
- I. Sheet metal plenums shall be constructed and reinforced in accordance with SMACNA standards. Where plenums are connected to louvers, the plenum bottom shall be sloped to drain to the louver.
- J. Ductwork which is exposed to weather shall have soldered joints and seams and shall be painted with a suitable epoxy coating.

3.2 COORDINATION:

- A. Prior to submitting ductwork shop drawings, the Division 23 Contractor shall fully coordinate the routing and height of all ductwork with all other trades and with ceiling heights, lighting fixtures and building construction. Where ductwork is concealed, bottom of duct shall be a minimum of 8" above the ceiling unless otherwise noted. Where ductwork is exposed, bottom of horizontal duct shall be a minimum of 6'-6" above finished floor. Where ductwork is exposed in occupied areas it shall be tight to the structure and the bottom of the duct shall be minimum 6'-6" above finished floor.

3.3 GENERAL DUCTWORK FABRICATION:

A. Duct Gauge and Reinforcing:

1. Rectangular Ductwork: Minimum metal gauges and reinforcement shall be in accordance with SMACNA HVAC Duct Construction Standards (SDCS) Tables 1-3 through 1-13. Minimum aluminum gauges and reinforcement shall be in accordance with SDCS Tables 1-14 through 1-16. Reinforcing shall be installed per SDCS Fig. 1-9 through 1-12.
2. Round Ductwork: Minimum metal gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-2. Minimum aluminum gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-3. Longitudinal seam ductwork larger than 12" diameter shall not be permitted unless welded seams are used.
3. Cross-breaking: Cross-break or transverse bead all flat surfaces which are more than 12" wide. Transverse beading shall be on 12" centers and shall be a minimum of 1/8" deep at the center of the bead and 3/8" wide at the base of the bead.
4. Minimum Gauges: The metal gauges listed in the SDCS for round and rectangular ductwork are the minimum recommended. It shall be the Contractor's responsibility to select a metal gauge heavy enough to withstand the physical abuse of installation.

B. Duct Joints And Seams:

1. General: Make all joints airtight. The distance between transverse joints on any size duct shall not exceed 5'.
2. Rectangular Ductwork: Transverse joints and longitudinal seams in ductwork shall be constructed in accordance with SDCS Fig. 1-4 and 1-5. Drive slips may be used on rectangular ductwork on short sides only, up to 18" maximum. Gauge of drive slips shall be at least as heavy as ductwork on which they are installed. Bend drive slips over at least 3/4" at corners. Corner closures shall be in accordance with SDCS Fig. 1-13 through 1-18. All longitudinal seams shall be "Pittsburgh Lock" or button punch snap lock at corner seams and grooved seam or seam welded in sides between corners, in accordance with SDCS Fig. 1-5. At the Contractor's option, transverse joints may be transverse duct flange joints or Ductmate EP12/11 prefabricated galvanized "Ductmate" sections. The proposed gasket material, flange, corner piece and Ductmate details shall be submitted for approval.
3. Round Ductwork: Transverse joints for round ductwork shall be beaded sleeve type constructed in accordance with SDCS Fig. 3-2, properly secured and sealed. Draw bands shall not be used on round ductwork. Longitudinal and spiral seams shall be constructed in accordance with SDCS Fig. 3-1.

4. Ductwork Sealing: Seal all longitudinal and transverse ductwork joints and seams using SMACNA ductwork sealant and 3" wide open weave tape to provide positive seal. Sufficient sealant shall be used to completely imbed the cloth.
- C. Connections and Take-offs:
1. Rectangular Ductwork: Parallel flow branches shall be constructed using radius elbow take-offs in accordance with SDCS Fig. 2-7. Branch duct connections shall be 45 degree entry expanded taps constructed in accordance with SDCS Fig. 2-8. Duct-mounted coil connections shall be constructed in accordance with SDCS Fig. 2-11.
 2. Round Ductwork: Connections and takeoffs shall be made using 90 degree conical taps, 45 degree lateral taps or wye fittings constructed in accordance with SDCS Fig. 3-4 and 3-5. Use of 90 degree tees shall not be allowed.
 3. Spin-in Fittings: Spin-in fittings may be used for duct taps to air supply and exhaust devices and shall include quadrant dampers even though a volume damper may be specified for the air device. Spin-in fittings shall be sealed at the duct tap with a gasket and compression fit or sealed with duct sealant. The location of spin-in fittings in the ducts shall be determined after terminal units are hung and the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends. Spin-ins shall be installed with their damper axis parallel to airflow.
 4. Flexible Joints In Ductwork: Provide flexible connections where ductwork connects to air-handling units, fans, and similar powered equipment items and where required for expansion and contraction of the ductwork or the building structure. A minimum of one inch (1") slack shall be provided in all flexible connection to insure vibration isolation. Flexible joints are not required where equipment is connected with flexible duct. Flexible connections shall be rigidly connected to metal work on each side and shall be airtight. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.
- D. Elbows and Tees:
1. Rectangular Ductwork: Provide radius or square elbows in ductwork, where shown on the Drawings. Where radius elbows are shown, radius elbows must be provided. Where square elbows are shown, square or radius elbows may be provided, at the Contractor's option. Elbows shall be constructed in accordance with SDCS Fig. 2-2. Turning vanes are required in all square elbows of 46 degrees or greater angle. Turning vanes are not required in radius elbows. Turning vanes shall be single vane type without a trailing edge and shall be constructed and installed in accordance with SDCS Fig. 2-3 and 2-4.
 2. Round Ductwork: Provide radius elbows of the stamped or segmented type constructed in accordance with SDCS Fig. 3-3. Segmented elbows shall have a minimum of three segments for 45 degree elbows and five segments for 90 degree elbows.
- E. Offsets and Transitions: Where duct width increases, maximum angle of slope shall be 20 degrees (one inch (1") in 2.7"). Where duct width decreases, maximum angle of slope shall be 30 degrees (one inch (1") in 1.7"). Offsets and transitions shall be constructed in accordance with SDCS Fig. 2-9 (type 2 and 3 only) and 2-10 (exclude C and E).
- F. Air Device Connections: Make connections to air devices and fabricate air device plenums as detailed on the Drawings and in accordance with SDCS Fig. 2-16 through 2-18.

3.4 DUCTLINER:

- A. General: The liner shall be applied to the inside of the duct with heavy density side to the air stream and shall be secured in the duct with adhesive, completely coating the clean sheet metal. All joints in the insulation shall be "battered" and firmly butted tightly to the adjoining liner using fireproof adhesive. Where a cut is made for duct taps, etc., the raw edge shall be accurately and evenly cut and shall be thoroughly coated with fireproof adhesive. On ducts over 24" in width or depth, the liner shall be further secured with mechanical fasteners. The fasteners shall be A.J. Gerrard Company pronged straps, or approved equal, secured to the ducts by fireproof adhesive. The clips shall be 18" maximum spacing and shall be pointed up with fireproof adhesive. Liner shall be accurately cut and ends thoroughly coated with fireproof adhesive so that when the duct section is installed, the liner shall make a firmly butted and tightly sealed joint. Ductliner for velocities over 2500 fpm shall be as specified except a perforated metal liner shall be used over ductliner for securement, in lieu of fasteners. Ductliner installation and fasteners shall comply with SDCS Fig. 2-22 through 2-25.

3.5 DUCTWORK INSTALLATION:

- A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and noiseless systems, capable of performing each indicated service. Install each run with a minimum of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of the type which will hold ducts true-to-shape and prevent buckling.
- B. Inserts: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in the work.
- C. Completion: Complete fabrication of work at the project as necessary to match shop-fabricated work and accommodate installation requirements.
- D. Run Location: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, grams, details, and notations or, if not otherwise indicated, run ductwork in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building. Limit clearance to 0.5" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork to assure 1.0" clearance of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate the layout with suspended ceiling and lighting layouts and similar finished work.
- E. Coordination: Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of the ductwork system.

F. Hangers and Supports:

1. General: All ductwork supports shall be per Section IV of the SMACNA "HVAC Duct Construction Standards - First Edition" with all supports directly anchored to the building structure. Supports shall be on maximum 8'-0" centers with additional supports as required to prevent sagging.
2. Attachment to Structure: Provide hanger attachment to the building structure as specified in Section 23 03 00, "Basic Materials and Methods", and in accordance with SDCS Fig. 4-1 through 4-3.
3. Hangers: Hangers shall be strap or rod sized in accordance with SDCS Table 4-1 and 4-2. Strap hanger attachment to rectangular duct shall consist of a turning strap under the duct a minimum of one inch (1") and securing the strap with one screw into the bottom of the duct and one screw to the side of the duct. Rectangular duct supported on trapeze hangers shall be attached to the trapeze. Round duct attachments shall be constructed in accordance with SDCS Fig. 4-4.
4. Horizontal Ducts: Ducts larger than 50" in their greatest dimension shall be supported by means of hanger rods bolted to angle iron or half round trapeze hangers. Duct shall have at least one pair of supports 8'-0" on centers according to the following:

<u>Angle Length</u>	<u>Angle</u>	<u>Rod Diameter</u>
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

5. Vertical Ducts: Ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

G. Flexible Ductwork:

1. General: Flexible ductwork shall be provided as shown on Drawings. Flexible ducts shall be installed in a fully extended condition free of sags and kinks, using only the minimum length required to make the connection, subject to the maximum lengths hereinbelow. Bends in any length of flexible duct shall not exceed 45 degrees for HVAC terminal unit connections or 90 degrees for air device connections and shall not exceed that recommended by the flexible ductwork manufacturer. Unless otherwise shown on the Drawings, the length of any one run of flexible ductwork shall not exceed 1'-6" for HVAC terminal unit connections or 8'-0" for air device connections. Where longer runs are required, provide externally insulated rigid duct extensions.
2. Supports: Where flexible duct extension exceeds 36", horizontally, a support shall be provided. Duct shall be suspended on 36" centers with a minimum 3/4" wide flat banding material and a minimum 6" wide sheet metal protective saddle. Refer to SDCS Fig. 3-9 and 3-10 and Page 3-17 for additional requirements.
3. Terminal Unit Flexible Duct Connections: All flexible duct connections upstream of HVAC terminal units shall be made by turning back the insulation and securing the inner liner with duct sealer and 1/2" wide positive locking stainless steel straps. The insulation shall then be placed over the joint and sealed on the exterior with self-locking

nylon straps and an approved metalized duct tape. Refer to SDCS Page 3-13 and 3-15 for additional requirements.

4. Air Device Flexible Duct Connections: All air device flexible duct connections shall be made by turning back the insulation and securing the inner liner with 1/2" wide positive locking stainless steel straps or self-locking nylon straps and sealing with an approved metalized duct tape. The insulation shall then be placed over the joint and sealed on the exterior with an approved metalized duct tape. Spin-ins for air device taps shall be installed with their damper axis parallel to air flow. Refer to SDCS Page 3-13 and 3-15 for additional requirements.

H. Duct Mounted Devices:

1. Install duct mounted sensors and control devices furnished under [Section 23 06 00, "Building Controls and Automation". Provide access doors at each duct mounted control device. Coordinate location of devices and installation requirements with the Section 23 06 00 Contractor.
2. Install duct type smoke detectors furnished under Division 26. Provide access doors at each sampling tube assembly. Coordinate location of detectors and installation requirements with Division 26.
3. Provide duct test ports in ductwork at locations shown on the drawings and as required to properly balance all air systems. Test ports shall be located per ANSI/ASHRAE Standard III to allow accurate pitot-tube traverse measurements in ductwork.

3.6 CLEANING AND PROTECTION:

- A. General: Clean ductwork internally, section-by-section of dust and debris as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of the metal or, where ductwork is to be painted, might interfere with painting or cause paint damage.
- B. Repairs: Strip protective paper from stainless ductwork surfaces and repair finish or replace ductwork portion wherever it has been damaged.
- C. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent the entrance of dust and debris until such time that connections are to be completed.

3.7 TESTING:

- A. General: Provide duct integrity and leakage testing for all supply, return and exhaust ductwork installed on the project. Testing shall be in accordance with the SMACNA HVAC Air Duct Leakage Test Manual, First Edition, 1985 (DLTM) and shall include, but not be limited to:
 1. Test Complete Systems: Duct systems shall be tested as complete systems (e.g. from air handling equipment to terminal units/air devices, from terminal units to air devices or from air devices to exhaust (return fans). Duct systems shall not be tested in partial sections, unless approved in writing by the Engineer.
 2. Preparation for Testing: Duct system installation must be complete, including, but not limited to, fittings, spin-ins, taps, access doors, hangers, test ports/holes, dampers and other system components. Temporary caps shall be installed at the system inlet

(supply air system), system outlet (exhaust/return air systems) and at all terminal unit/air device taps.

3. Leakage Calculations: Prior to testing a duct system, the permissible leakage rate in cfm shall be calculated based on the square feet of duct surface and the duct system leakage classification.
4. Test Configuration: The configuration for testing shall be similar to DLTM Fig. 3-1, using a variable volume blower as a test air source, an orifice plate meter with an inclined manometer to measure leakage cfm and a manometer to measure duct static pressure.
5. Acceptable Results: Duct systems shall be tested, resealed and retested until acceptable results are obtained, eg. the measured leakage rate is equal to or less than the calculated permissible leakage rate.
6. Documentation: Duct system leakage testing results shall be recorded on forms which include the following information as a minimum:
 - a. Duct System Tested.
 - b. System Leakage Classification.
 - c. Duct System Square Footage.
 - d. Permissible Leakage Rate in CFM.
 - e. Duct Test Pressure.
 - f. Orifice Size.
 - g. Measured Pressure Differential.
 - h. Measured Leakage Rate in CFM.
 - i. Measured Duct Pressure.
 - j. Test Performed By.
 - k. Date/Time of Test.
 - l. Temperature and Weather Conditions of Test.
7. Duct leakage test reporting forms shall be submitted to the Engineer for approval.

B. Leakage Classifications:

1. Constant Volume Supply Air Ductwork: Ductwork shall be tested at leakage Class 12 at +2" wg.
2. Return Air Ductwork: Ductwork shall be tested at leakage Class 12 at -1" wg.]

END OF SECTION 23 31 13

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

This Page is Intentionally Blank

SECTION 23 31 14 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide ductwork accessories as shown on the Drawings, specified and required.
- B. Types: The types of ductwork accessories required for the project include, but are not limited to:
 - 1. Flexible connections.
 - 2. Direction and volume control dampers.
 - 3. Fire/smoke dampers.
 - 4. Flashing and counterflashing.
 - 5. Turning vanes.
 - 6. Duct access doors and inspection plates.
 - 7. Test openings.
 - 8. Miscellaneous ductwork materials.

1.3 QUALITY ASSURANCE:

- A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) "HVAC Duct Construction Standards", 1985 Edition.
- B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
- C. Certification: Fire, fire/smoke and smoke dampers shall be UL-listed, FM-approved and comply with applicable building code requirements.
- D. Manufacturers: Provide products complying with the specifications and produced by one of the following:
 - 1. American Foundry.
 - 2. Duro-Dyne.
 - 3. Elgin Sheet Metal Products.
 - 4. Nailor Industries.
 - 5. Prefco.
 - 6. Ruskin.

7. Tuttle and Bailey.
8. United Sheet Metal.
9. Vent-Fabrics, Inc.
10. Ventlok.
11. Young Regulator Co.

1.4 SUBMITTALS:

- A. Shop drawings submittals shall include, but not be limited to, the following:
 1. Cut sheets of ductwork accessories, clearly indicating materials, construction dimensions, ratings, approvals, and other pertinent information.
 2. Manufacturers' UL-approved installation instructions for fire, fire/smoke, and smoke dampers.
 3. Additional information as required in Section 23 00 01. "Mechanical General Provisions".

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver ductwork accessories in factory-fabricated water-resistant wrapping.
- B. Handle ductwork accessories carefully to avoid damage to material component, enclosure and finish.
- C. Store ductwork accessories in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 DUCTWORK ACCESSORIES, MATERIALS, AND FABRICATION:

- A. General: Provide ductwork accessories which comply with Sections 23 01 00, "Ductwork", and 23 31 14, "Ductwork Accessories", for applicable product requirements of ductwork materials and as required for a complete ductwork system installation.

2.2 FLEXIBLE CONNECTIONS:

- A. General: Flexible connections shall be minimum 3" wide and be UL-labeled, 30 ounces glass fabric-lined with insulation and coated on both sides with neoprene, complete with attachment accessories, "Vent-Glass" by Vent-Fabrics, Inc., Elgen "Zipper-lock" HZ-LN-14, Duro-Dyne Excelon "Metal-Fab", flexible connections shall be fabricated in accordance with Fig. No. 2-19 of the SMACNA HVAC Duct Construction Standards, 1985 Edition, or approved equal.

2.3 DIRECTION AND VOLUME CONTROL DAMPERS:

- A. General: Provide all direction and balancing (volume control) shown or noted on Drawings. All damper control devices shall be installed so as to be fully concealed in finished rooms and spaces.

B. Control Dampers:

1. Splitter Dampers: Splitter dampers shall be fabricated of steel not lighter than 16 gauge. The leading edge of the damper shall be hemmed. Each splitter shall be a minimum of 12" long or 1-1/2 times the width of the smaller of the two branches it controls, whichever is greater. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, Ventlok No. 644 on exposed externally insulated ductwork and Ventlok No. 677 (2-5/8" diameter) chromium plated cover plate for concealed ductwork not above lay-in accessible ceilings, or approved equals.. Furnish and install end bearings for the damper rods on the end opposite the quadrant when Ventlok No. 555 or No. 644 regulators are used, and on both ends when Ventlok No. 677 regulators are used. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers. Dampers larger than 3 square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and bearings supporting the axle.
2. Balancing Dampers: Balancing dampers shall be provided in all zones of multi-zone air handling units, in all air device taps and where shown on the drawings. Refer to Section 23 01 00 "Ductwork" for air device flexible duct taps. Balancing dampers shall consist of single blade dampers in rigid round duct and rectangular duct up to 10" high and 12" wide, and opposed blade dampers in ducts 11" high and larger. Single blade dampers shall be in accordance with Fig. 2-14 of the SMACNA HVAC Duct Construction Standards (SDCS), 1985 Edition, and opposed blade dampers shall be in accordance with SDCS Fig. No. 2-15. Single blade dampers for rectangular duct shall be Ruskin MD35 22 ga. single blade galvanized steel dampers or an approved equal. Single blade dampers for round duct shall be Ruskin MDRS35 20 ga. single blade galvanized steel dampers. Single blade dampers shall be provided with full length 3/8" square shafts secured to the damper blade with a minimum of 2 U-bolts, nylon bearings, insulation build out and heavy duty locking hand quadrants. Opposed blade dampers for rectangular duct shall be Ruskin MD35/OB 16 ga. Galvanized steel opposed blade dampers or an approved equal. Opposed blade dampers shall be provided with full length 1/2" square shafts, concealed linkage, nylon bearings, insulation build out and heavy duty locking hand quadrants. Air pressure drop through each balancing damper not to exceed 0.05" wg at design airflow. All balancing dampers shall have 100% free area with damper open.
3. Damper Regulators: Damper regulators for concealed accessible applications shall be Young Valcalox 400 series lever handle damper quadrants or an approved equal. Where regulators are installed on externally insulated ductwork, provide stand-off platforms at least 1/4" higher than the insulation thickness. Where damper regulators are required in non-accessible locations, provide access doors or Young or equal extension rods, couplings, 90 degree gear drives, etc. as required and Young 301 or approved equal flush mounted remote regulator as directed by the Architect.
4. Extractors: Provide extractors of the size and type indicated, with hex-key operated adjustable blades, with gang operated galvanized steel blades on one inch centers.
5. Backdraft Dampers: Provide all aluminum gravity type backdraft dampers with an extruded frame and roll formed blades with silicon impregnated felt seals. Blade height shall not exceed 4", blade width shall not exceed 48" and blade linkage shall be provided to gang operate dampers by section.

- C. Operators: Damper operators for concealed inaccessible ductwork shall be Young Regulator Company, Catalog No. 700 or No. 315, as shown. Non-insulated accessible ductwork shall be Young Regulator Company, Catalog No. 433. Accessible insulated ductwork shall be Young Regulator Company, Catalog No. 443. Approved equal units by Duro-Dyne or Vent Fabrics, Inc. will be acceptable.

2.4 FIRE/SMOKE DAMPERS:

- A. General: Provide low leakage fire/smoke dampers at all locations shown on the Drawings or required. Dampers shall be multi-blade type combination fire/smoke dampers and shall possess a 1-1/2 hour UL label in accordance with UL 555S and shall meet all requirements of the latest edition of NFPA 90A and 101. Dampers shall be tested and certified in accordance with AMCA Standard 500-75 and shall leakage Class II per UL Standard 555S.
1. Fire/smoke dampers and operators shall be UL-listed and labeled in the sizes used on the project and all dampers on the project shall be by the same manufacturer. UL-labeling of damper sizes used on the project shall be clearly indicated on shop drawing submittals.
 2. Dampers shall be suitable for opening and closing at static pressure up to 6" wg and at air velocities up to 3500 fpm. Damper leakage shall not exceed 10 cfm/sf at one inch wg or 200 cfm/sf at 4" wg.
 3. All combination fire/smoke dampers shall include an operating shaft which, when rotated, causes the damper to operate between open and closed. Operating shaft and damper combination shall be suitable for linking to and operation by any standard electric damper operator having sufficient torque characteristics. Combination fire/smoke dampers shall be Ruskin Type FSD-60 or an approved equal with 212°F thermal links and rectangular, round or oval duct connections as required.
 4. Each combination fire/smoke damper shall be furnished complete with factory sleeve, damper operator, and thermal link factory-installed. The installing contractor shall be responsible for coordinating locations which require a special sleeve. Actuators shall be electric type as specified or required and shall be of the spring fail closed type that will close upon loss of power. Damper operators shall be UL-listed as fire damper operators, shall bear the appropriate UL fire damper operator label and shall be rated for continuous operation at 250°F.
 5. All wiring and materials to interface the controls with the fire detection and alarm systems shall be furnished and installed under Division 26. Dampers shall be installed with angle iron frames and slip joint connections per manufacturer's recommendations and SMACNA Standards such that they are self-supporting in the case of duct destruction due to heat. Provide access doors as specified under Ductwork for all internally actuated dampers and for maintenance inspection of all externally actuated dampers. Where duct access doors are installed in non-accessible locations, provide ceiling or wall access doors. Label duct access doors "FIRE/SMOKE DAMPER ACCESS" with 1/2" high black stencil letters.

2.5 FLASHING AND COUNTERFLASHING:

- A. General: Flashing and counterflashing shall be as specified in other Divisions of these Specifications.

2.6 TURNING VANES:

- A. General: Provide turning vanes in the size and type indicated with the following additional construction features:
 - 1. Blades: 2" galvanized steel for up to and including 18" ducts.
 - 2. Blades: 4-1/2" galvanized steel for ducts over 18".
 - 3. Construction: Single wall blade, constructed in accordance with Fig. No. 2-3 and Fig. No. 2-4 of the SMACNA HVAC Duct Construction Standards, 1985 Edition.
 - 4. Types: Fixed blades for 90 degree elbows, adjustable for transition elbows and fixed for 45 degree elbows where shown.

2.7 DUCT ACCESS DOORS AND INSPECTION PLATES:

- A. Access Doors: Provide Ruskin Type ADH2, Flexmaster Inspector Series Tab Doors or approved equal dual wall, insulated, hinged access doors in ductwork as required for access to fire, smoke and fire/smoke dampers, duct smoke detectors, sampling tubes, humidifiers and other duct mounted devices. Minimum door size shall be 14" x 14" unless a smaller size is required due to duct dimensions.
- B. Inspection Plates: Provide inspection plates where shown on the Drawings. If not detailed, provide a minimum opening of 4" x 4" with a 6" x 6" cover plate. The cover plate shall be one gauge heavier than the ductwork, gasketed and secured with a minimum of eight sheet metal screws.

2.8 TEST OPENINGS:

- A. General: Ventlok No. 699 instrument test holes in locations as required to measure pressure drops across each item in the system, e.g., O.A. louvers, filters, fans, coils, intermediate points in duct runs, etc. Test holes in stainless steel duct systems shall be 316 stainless steel or an approved corrosion resistant design.

2.9 MISCELLANEOUS DUCTWORK MATERIALS:

- A. General: Provide miscellaneous materials for ductwork accessories, including hinges, refrigerator latches, sash locks, bolts and wing nuts, gaskets and pitot tubes as recommended by the ductwork accessories manufacturer for the application indicated.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Flexible Connections: Install flexible connections where ducts connect to fans, including roof exhausters. There shall be a minimum of 1/2" slack in the connections, and a minimum of 2-1/2" distance between the edges of the ducts except that there shall also be a minimum of one inch (1") of slack for each inch of static pressure on the fan system.
- B. Dampers: Install balancing, splitter and backdraft dampers where shown on the Drawings and wherever necessary for complete control of the airflow, including all supply, return and exhaust branches, "division" in main supply, return and general exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, this Contractor shall be responsible for the proper location of the access doors. Install balancing dampers in each zone of multi-zone units.

- C. Fire/Smoke Dampers: Install fire/smoke dampers as detailed on the Drawings and in strict accordance with the damper manufacturers UL-approved installation instructions.
- D. Flashing: Install flashing where ducts pass through roofs or exterior walls, suitable flashing shall be provided to prevent rain or air currents from entering the building. The flashing shall be of not less than No. 24 gauge 316 stainless steel.
- E. Turning Vanes: Install turning vanes per SMACNA standards. Turning vanes in ducts carrying air under pressure of 1-1/2" water gauge or more shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.
- F. Access Doors: Install access doors so that the doors open against the system air pressure wherever feasible and that their latches are operable from either side, except where the duct is too small to be entered. Provide access to each fire damper link to permit resetting. Comply with City Code Requirements and NFPA 96. Install hinged access doors in ductwork to provide access to all fire dampers, mixed air plenums, upstream of steam reheat coils, automatic dampers, etc. Where the ducts are insulated, the access doors shall be double skin doors with one inch of insulation in the door. Where access doors are located above a suspended ceiling, this Contractor shall be responsible for the proper location of the ceiling access doors, if the ceiling system does not provide proper access.
- G. Inspection Plates: Install plates at each multi-zone zone damper and where otherwise indicated on the Plans.
- H. Test Openings: Install test openings for pitot transverse of all supply, return, and exhaust duct connections to fan powered equipment, at each duct mounted balancing damper and at other locations required for proper measurement of airflow in all duct systems.

3.2 TESTING:

- A. General: Check installed ductwork accessories for required operation and leakproof performance during the system's operational test. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- B. Damper Testing: Test all fire, fire/smoke and smoke dampers for proper operation after the damper installation is complete. Dampers which exhibit any binding or other forms of impaired operation shall be replaced and retested. Refer to Section 23 05 93 for additional requirements.
- C. Damper Certification: The Contractor shall include in the Operating and Maintenance Manuals, a letter certifying that all fire, fire/smoke and smoke dampers have been tested and are fully operational. Refer to Section 23 05 93 for additional requirements.

END OF SECTION 23 31 14

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

SECTION 23 37 13 - AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 01, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide air distribution devices and accessories as specified, scheduled and shown on the Drawings.
- B. Types: The types of air distribution devices required for the project include, but are not limited to:
 - 1. Ceiling diffusers.
 - 2. Registers and grills.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Devices manufactured by Nailor, Metal-Aire, Titus or Krueger, will be acceptable if the devices furnished comply with these Specifications, the conditions scheduled and are similar in appearance and performance to the units scheduled.
- B. NFPA Compliance: Comply with National Fire Protection Association (NFPA) Standard NFPA 90, as applicable to air diffuser construction and installation.
- C. Design Compliance: When directed by the Engineer, test air outlets to verify compliance with these Specifications. Perform all revisions required to comply with terminal velocity, noise level or maximum temperature variation requirements at no cost to the Owner or Engineer.
- D. Air Distribution Equipment: Maximum space temperature variation shall not exceed 2°F through the conditioned area from 2' above the floor, to 7' above the floor. The air outlets shall be selected by the manufacturer to suit the volume, throw and noise level scheduled as shown on the Drawings and maintain maximum terminal velocities of 50 fpm, unless otherwise indicated.

1.4 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Submit cutsheets on air devices clearly indicating all features, accessories, mounting provisions, throw, pressure drop, noise criteria, controls and other pertinent performance data clearly indicated.
 - 2. Submit test data and results as specified herein. Test results shall be certified by an authorized officer of the company.
 - 3. Additional information as required in Section 23 00 01, Mechanical General Provisions".

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver air distribution devices in factory-fabricated water-resistant wrapping.
- B. Handle air distribution devices carefully to avoid damage to material component, enclosure, and finish.
- C. Store air distribution devices in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 AIR DISTRIBUTION DEVICE GENERAL REQUIREMENTS:

- A. General: Provide air distribution devices of the size, shape, and type, constructed of materials and components and with finishes as scheduled and shown on the Drawings. Grilles, registers and ceiling outlets shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 fpm nor less than 25 fpm. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level).
- B. Compatibility: Air distribution devices shall be fully compatible with the surfaces in which they are installed and shall be provided with all required mounting accessories for installation in the actual construction at the installation location.
- C. Finishes: All ceiling and wall mounted air devices shall be painted white or off white unless specified otherwise and all air devices shall be the same color. Where the factory finish on all devices is not the same as determined by the Architect/Engineer, then the Division 23 Contractor shall be responsible for coordinating field painting of air devices by the Division 9 Contractor. The Division 23 Contractor shall be responsible for all costs associated with painting of white or off white air devices. Special color painting of air devices shall be the responsibility of the Division 9 Contractor. The Architect/Engineer's decision on white color compatibility is final.
- D. Ceiling Diffusers: Provide diffusers with corrosion resistant treated surfaces and finished in off-white baked enamel unless otherwise specified, scheduled, or shown on the Drawings. Provide opposed volume control dampers with supply air diffusers where scheduled. Where applicable, provide adapters with diffusers to permit connection to round supply duct. The interior of all perforated plate diffusers shall be painted flat black. Perforated plate supply air diffusers shall have pattern control blades installed in the diffuser neck. Pattern controllers attached to the perforated plate are **not** acceptable. Provide concealed fastening on all ceiling diffusers.
- E. Registers and Grilles: Provide registers which contain a key-operated multilouvered opposed blade damper operable from the face side, unless scheduled otherwise. Supply air registers shall be of the double deflection type, unless scheduled. Return air grilles and registers shall have fixed face blades and match the face of the supply air registers, unless scheduled otherwise. Provide concealed fastening for all registers and grilles.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install air distribution devices in accordance with manufacturer's written instructions and recognized industry practices to ensure that products serve intended functions.
- B. Coordination: Coordinate with other trades, including ductwork, and ductwork accessories, as necessary to interface air distribution devices properly with other work.
- C. Locations: Locations of air distribution devices shown on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures. Where air distribution devices are installed in acoustical tile and other ceilings they shall be either centered on tile or ceiling joints as directed by Architect at job site. Coordinate location of all ceiling air devices with Architectural reflected ceiling plans.
- D. Mounting Provisions: Coordinate mounting provisions and accessories required for proper installation of air devices in finish and construction at the point of installation. Refer to details on the Mechanical and Architectural Drawings for special installation details and provide all mounting accessories shown or required for the complete and proper installation of each air device.
- E. Accessories: Where scheduled, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual balancing damper. These devices shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

3.2 BALANCING ACCESSORIES:

- A. General: Provide factory-calibrated balancing cones for use in air balancing all types of ceiling outlets, linear diffusers or any other special outlet. All cones shall be calibrated for use with Alnor velometer and identified with airflow factors permanently indicated on the sides of the cones.

3.3 FIELD QUALITY CONTROL:

- A. Test: Test installed devices to demonstrate satisfactory compliance with specified and indicated requirements.
- B. Adjustment: Adjust air distribution devices to provide air distribution patterns shown on the drawings or required.
- C. Air Balancing: Balance the airflow through each air device to the volumes shown on the Drawings. Refer to Section 23 05 93 for additional balancing requirements.

END OF SECTION 23 37 13

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068

This Page is Intentionally Blank