Project Manual
for
The University of Texas MD Anderson Cancer Center
Houston, Texas
RB Floor Care Equipment Wash Area

MD ANDERSON PROJECT : 18-0043
A/E PROJECT : CH+P No. 18-029

PROJECT DELIVERY METHOD : JOC
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The University of Texas
MD Anderson Cancer Center
MS052616

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PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

C. The Contractor’s attention is specifically directed, but not limited, to the Uniform General and Supplementary General Conditions for University of Texas System Building Construction Contracts (UGC) for other requirements.

D. Attachment “A” (To Owner’s Special Conditions) – Minimum Wage Rate Determination. Pursuant to the UGC, the attached schedule identifies the Prevailing Wage Rate determination as applicable to the Project location.

E. Attachment “B” (To Owner’s Special Conditions) – Facilities Planned Utility Outages Policy.

1.02 SUMMARY

A. Terms and conditions set forth in this document are for the Contractor only, and are valid regardless of the project delivery method. For Construction Manager at Risk or Design/Build, the final version of the document shall be confirmed by the Owner, and included by the Construction Manager or Design/Build Contractor in the Guaranteed Maximum Price Proposal. For projects for which the construction phase is divided into multiple stages, these Owner’s Special Conditions shall be reviewed, updated as warranted, and resubmitted with GMP Proposal associated with that stage of the construction work.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1. Texas Medical Center Architectural Standards and Texas Medical Center Stormwater Management Design Guidelines are applicable to all Projects located within the Texas Medical Center.

2. Owner’s underwriter requirements are applicable to all Projects.
1.04 DEFINITIONS

A. The term “Owner’s Project Manager” as used throughout the Contract Documents means an individual authorized by the Owner to administer the Project.

B. Outage - A temporary disruption of normal operation or use of utilities, sidewalks, parking areas, driveways or facility access.

C. Planned Utility Outage - An event that can be foreseen and has a plan of action in place to accomplish specific tasks during a utility outage.

D. Utility - Any service provided by an outside source or manufactured in house (gas, water, electricity, fire suppression water, telecommunications, data systems, building automation systems, fire alarm systems, etc.) which facilitates building operations.

E. The terms “outage” and “shutdown” are used interchangeably throughout the Contract Documents.

F. Work Day - A day in which work is planned, excluding weekends and holidays.

G. The terms “work day” and “business day” are used interchangeably throughout the Contract Documents.

H. Normal working hours are considered as work being performed between 6:00 A.M. and 6:00 P.M. Monday through Friday, excluding holidays.

I. The terms “normal hours” and “regular hours” are used interchangeably throughout the Contract Documents.

J. Weather Day – A “weather day” is a day on which the Contractor’s current schedule indicates Work is to be done, and on which inclement weather occurs and resultant site conditions or inaccessibility to the site prevent the Contractor from performing five hours of Work associated with the Project’s critical activities during normal working hours.

1.05 OWNER’S RIGHT OF OCCUPANCY

A. The Owner may occupy or use all or any portion of the Work following Substantial Completion, or at any earlier stage of completion. Should the Owner wish to use or occupy the Work, or part thereof, prior to Substantial Completion, the Owner’s Project Manager will notify the Contractor in writing and identify responsibilities for security, maintenance, and insurance.

B. Work performed on the premises by third parties on the Owner’s behalf does not constitute occupation or use of the Work by the Owner for purposes of this Article.

C. All Work performed by the Contractor after occupancy, whether in part or in whole, shall be at the convenience of the Owner so as to not disrupt Owner’s use of, or access to occupied areas of the project.

D. Contractor shall follow the Planned Utility Outage Procedure specified within this section when performing Work affecting any occupied facility.
1.06 MINIMUM WAGE RATE DETERMINATION
A. The Contractor shall comply with all requirements of Texas Government Code Chapter 2258, Prevailing Wage Rates.
B. Wage rates identified in Attachment “A” (To Owner’s Special Conditions) are titled “Prevailing Wage Determination, dated December 31, 2009.
C. The Owner may verify wage rate compliance in the field by interviewing workers. The Contractor shall assist the Construction Inspector (CI) with this task, including providing translation for non-English speaking workers.

1.07 WEATHER DAYS
A. Weather days are excusable delays. When weather conditions at the site prevent work from proceeding, immediately notify the Owner’s Project Manager for confirmation of the conditions. At the end of each calendar month, submit to the Owner’s Project Manager a list of Weather Days occurring in that month along with documentation of the impact on critical activities. Based on confirmation by the Owner’s Project Manager, any time extension granted will be issued by Change Order. If the Contractor and Owner cannot agree on the time extension, the Owner may issue a Unilateral Change Order for fair and reasonable time extension.

1.08 SEPARATE CONTRACTS
A. As provided in the UGC, the Owner may award other contracts for other portions of the Project. Additional separate contracts may include FF&E vendors/installers

PART 2 - PRODUCTS

2.01 GENERAL
A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 OWNER’S SPECIAL CASH ALLOWANCES (NOT USED)

2.03 BUILDERS RISK ENDORSEMENTS
A. For Coverage of Existing Building Structures:
1. Contractor shall include an endorsement on the Builders Risk Insurance policy to provide coverage for the existing building structure(s), including its/their contents, as described below. Coverage shall be in the amount equal to either $5 million or the estimated replacement value of the existing building structure and its contents, whichever is less.
2. The purpose of this coverage is to fund the $5 million deductible under the Owner’s existing property insurance policy which addresses the risk and possible cost of claims to repair damage to existing structure(s) (this purpose should be explained to the Builders Risk Insurance carrier when requesting the quote). The existing building structure(s) to be covered is the R.LEE CLARK CLINIC building, and its estimated building replacement value is $291,354,877.03. Its estimated contents value is $41,033,838.34.
B. Soft Costs, Loss of Rents, Gross Earnings:
   1. Contractor shall provide an alternate price to include an endorsement on the Builders Risk Insurance policy to provide the following additional coverage:
      a. Period of Indemnity 365 DAYS
      b. Maximum Deductible: 14 Days

C. Umbrella Liability Limits:
   1. For Non-ROCIP Projects, Limits as follows:
      a. No Umbrella Required
   2. If Contract Sum is greater than $1,000,000 up to $3,000,000:
      a. $1,000,000 each occurrence and $2,000,000 annual aggregate
   3. If Contract Sum is greater than $3,000,000 up to $5,000,000:
      a. $5,000,000 each occurrence and $5,000,000 annual aggregate
   4. If Contract Sum is greater than $5,000,000:
      a. $10,000,000 each occurrence and $10,000,000 annual aggregate

D. Builder’s Risk Limits
   1. For purpose of purchasing builder’s risk insurance on the entire Work, the cost of materials supplied or installed by others is currently estimated to be $xxxxxx.

2.04 TEMPORARY FIELD OFFICE STRUCTURES, FURNISHINGS AND EQUIPMENT
A. The Contractor shall coordinate and direct the Work of the Project from the Site.
B. The Contractor shall provide and maintain at least one (1) temporary field office that is adequately staffed, furnished, and equipped.
C. All arrangements for temporary field offices shall be as agreed upon with the Owner’s Project Manager. Costs for temporary field office(s) shall be included in the Contractor’s Schedule of Values Breakdown and included with the Contractor’s regular monthly Progress Payment.

2.05 TOILET FACILITIES
A. Contractor shall have access to selected existing toilet facilities located within the building. The Contractor shall coordinate with the Owner the toilet facilities that are available for use by the Contractor and their employees. The use if the toilet facilities other than those approved by the Owner are specifically forbidden by the Contractor and their employees for the duration of the project.
B. Contractor shall service, clean, and sanitize toilet facilities at least daily and as frequently as necessary to maintain them in a safe, clean, and sanitary condition. Contractor shall maintain at the Site, a record of the servicing, cleaning, and sanitizing of the facilities for the duration of the Project.

2.06 PROJECT COMMUNICATIONS PLAN

A. Depending upon the project, the Owner may develop a Project Communications Plan to inform the Owner’s faculty, employees, patients, visitors, and others concerning construction activities affecting them. Contractor shall participate and support this effort as required by Owner. Typical support by Contractor may include attendance at communications meetings, preparation of graphic and narrative construction impact updates, and the furnishing of targeted signage.

2.07 PROJECT SIGNAGE

A. For renovation projects, signage shall be in accordance with the Project Communications Plan or as directed by the Owner.

B. All hazard warning signage shall be OSHA 29 CFR Part 1926 compliant. All signs shall be prominently displayed at all entrances to the Site. Postings must be constructed of a durable material that will resist wear and damage.

C. Additional Contractor or Subcontractor signs or advertisements shall not be erected without the Owner’s written approval.

2.08 TEMPORARY WATER

A. The Owner shall make available to the Contractor the Owner’s existing water distribution system for use during the Project.

2.09 TEMPORARY POWER AND LIGHTING

A. The Owner shall make available to the Contractor the Owner’s existing power distribution system for use during the Project.

B. The Contractor shall provide adequate lighting about the Site for security, inspections of excavations, night shift work should such occur, and shall also provide adequate temporary interior lighting throughout the building enclosure to facilitate quality workmanship and appropriate inspection conditions.

C. Contractor shall ensure, and shall use emergency power equipment and connections if necessary to ensure, adequate lighting for egress and life safety.

2.10 TEMPORARY MECHANICAL SERVICES

A. The Owner shall make available to the Contractor the Owner’s existing mechanical distribution system for use during the Project.

B. If temporary heating, cooling, ventilation or humidity control equipment is required for protection of the Work or for implementation of indoor air quality measures, the Contractor shall provide Owner-approved equipment and proper operation such that no Work shall be damaged or life safety compromised.
C. All equipment and filters shall be maintained in good operation and all filters and controls shall be changed as a result of damage or expiration to ensure acceptable air quality. If necessary, all equipment must have current certifications.

D. After the permanent mechanical equipment has been installed and connected to the local chilled water and steam distribution systems, the equipment may be operated by the Contractor to heat or cool the building if acceptable to the Owner. Contractor must flush and clean all new mechanical piping systems before connecting to local systems.

E. During operation of the mechanical equipment, prior to achieving Substantial Completion, the Contractor shall keep the mechanical equipment in good operating condition, properly maintained, including cleaning and changing of all filters. New, non-construction filters shall be installed prior to the Owner’s acceptance of the mechanical equipment. The warranty period shall start for the respective equipment as delineated in the UGC.

2.11 REMOVAL OF TEMPORARY FACILITY

A. When a temporary facility is no longer needed for the proper conduct of the Work, the Contractor shall completely remove it from the Project and shall repair or replace any material, equipment, or finished surface damaged in doing so.

2.12 PROJECT PARKING

A. Contractor is responsible for securing adequate parking for Contractor’s employees. The Owner will not provide parking for the Contractor or the Contractor’s employees.

PART 3 - EXECUTION

3.01 CONTRACTOR SITE ACCESS AND LIMITS OF CONSTRUCTION

A. Upon authorization to mobilize, the Contractor shall submit a plan layout showing location of field offices, and utility tie-in locations for Owner review.

B. All Project personnel shall confine and limit their work and use of the Site to those areas within the defined limits of construction. All public and University rules, laws and requirements shall be obeyed and enforced by the Contractor. No tools, construction vehicles, or construction material other than those in transit, shall be permitted beyond the Site limits of construction, including Owner’s existing mechanical, plumbing, and electrical rooms, equipment rooms, and storage rooms.

C. All campus roads, drives, and fire lanes as well as all sidewalks and pedestrian routes, other than those specifically indicated to be in the Contractor’s area of control, must be kept open at all times. The Contractor shall proactively schedule and obtain security clearance for all significant material deliveries, vehicle traffic, street closures, cranes, concrete trucks, etc., through and around the campus and Site.
3.02 ON-GOING CAMPUS OPERATIONS

A. The Project is surrounded by and/or adjacent to continuously functioning campus facilities, including patient care, academic, and research efforts. The Contractor shall make every effort to avoid disruptions to ongoing campus activities and to maintain a safe environment for patients, students, faculty, and staff in the areas adjacent to the Project.

B. The Contractor shall obtain all Owner’s in-house approvals and permits. Operation of utilities and building systems must not be interrupted except when scheduled and approved in advance through established channels. The Contractor should be always mindful and proactive with regard to containment of noise, fumes, dust and debris.

3.03 CONTRACTOR’S RESPONSIBILITY OF THE PROJECT WORKFORCE

A. The Contractor is responsible for the actions of the entire Project workforce, including, but not limited to, subcontractors’ and suppliers’ employees, whenever they are on the campus. The Contractor shall submit a plan for identifying and controlling all workers, and for management of personnel records, including payroll records. Identification badges for workers, busing of workers from remote parking lot(s), written and verbal reminders to workforce of appropriate behavior and avoidance of campus facilities, and publishing of established access and egress routes for vehicular and pedestrian traffic are required, as a minimum, in order to maintain control of the work force.

1. Unacceptable behavior on the part of a worker anywhere on campus, including parking lots, the Site, and the accessing route(s) through the Site and through the campus, or failure to obtain parking permits, or traffic violations while on campus may lead to cancellation of any Owner provided parking. Identifiable offending worker(s) shall be permanently removed from the Project.

2. Harassment of any person, whether a patient, student, faculty, staff, or visitor to the campus, is strictly forbidden. Harassment includes any action such as jeering, whistling, calling-out, staring, snickering, making rude or questionable comments, or similar behavior. Identifiable offending worker(s) will be removed from the Project.

3.04 SECURITY

A. The Contractor is responsible for security of the Project. The University of Texas Police Department will not provide security for the Contractor’s areas unless under Project-specific agreement and terms of compensation.

B. The Contractor shall secure the Site at nights and weekends, or when no work is being performed, to prevent the entry of unauthorized personnel. Locks shall be of an approved type and have special keying as required by the Owner. Keys for all door locks shall be made available to The University of Texas Police Department. All doors accessing the construction site shall be properly latched and have closers to maintain closed doors at all times. All doors accessing the construction site shall have MD Anderson standard construction signage, provided by Owner’s Project Manager, to ensure that only authorized construction personnel access the site.
C. The Contractor shall not retain the services of outside guard or law enforcement services in connection with Work on campus without the specific prior written approval of the Chief of The University of Texas Police Department.

3.05 PROTECTION OF WORK

A. The Contractor shall properly and effectively protect all materials and equipment furnished during and after installation. Building materials, Contractor's equipment, etc., may be stored on the premises, but the placing of it shall be within the construction fence. When any room in the building is used as a shop, store room, etc., the Contractor shall be held responsible for any repairs, patching, or cleaning arising from such use. Contractor shall protect and be responsible for any damage to Contractor's Work or material, from the date of the agreement until the final payment is made, and shall make good without cost to the Owner, any damage or loss that may occur during this period. The Contractor shall handle all material as directed, so that the Architect/Engineer's representative may inspect it. All material affected by weather shall be covered and protected to keep it free from damage while being transported to the Site and while stored on the Site.

1. During the execution of the Work, open ends of all piping and conduit, and all openings in equipment shall be closed when Work is not in progress, and shall be capped and sealed prior to completion of final connections, so as to prevent the entrance of foreign matter.

2. All heating, ventilating, plumbing and electrical equipment shall be protected during the execution of the Work. All ductwork and equipment shall be sealed with heavy plastic and tape to prevent build-up of items such as dust, mold, and debris.

3. All ductwork and air handling mechanical equipment shall be wiped down with a damp cloth immediately before installation to ensure complete removal of accumulated dusts and foreign matter.

4. All plumbing fixtures shall be protected and covered so that no one can use them. All drains shall be covered until placed in service to prevent the entrance of foreign matter.

3.06 PLANNED UTILITY OUTAGE PROCEDURE

A. The Contractor shall not activate or de-activate any campus system, or component of any such system, without express written direction from the Owner.

B. Contractor shall schedule and obtain facilities approval for any necessary outage of campus utilities planning for a minimum of fifteen (15) work days in advance through the Owner's Project Manager, using the Owner provided “Contractor’s Request for Utility Shutdown” form and process. All outages shall be performed outside the normal working hours or as determined by the Owner.

3.07 NOISE CONTROL

A. Contractor shall coordinate equipment locations and timing or sequence of work operations so as to avoid conflict with the Owner's continuing use of adjacent buildings and/or avoid any interference with Owner's scheduled meetings, events, or business activities.
3.08 CUTTING, PATCHING, AND INSTALLATION OF SLEEVES

A. If cutting and/or patching of holes or openings is required for the execution of the Work, the Contractor shall consult with the Architect/Engineer prior to the commencement of any cutting and/or patching. Contractor shall leave all chases, holes, or openings straight, true, and of proper size as may be necessary for the proper installation of Work.

1. No excessive cutting of the structure shall be permitted, nor shall any piers or other structural members be cut without the written approval of the Architect/Engineer. After such Work has been installed, the Contractor shall carefully fit around, close up, repair, patch, and point-up as directed to the entire satisfaction of the Architect/Engineer.

2. All cutting and patching for utility penetrations shall be done carefully, with proper tools by qualified workers, without additional cost to the Owner. The Contractor shall build into the Work, as indicated on the Plans and/or Specifications, any and all items furnished by others. Cutting and repairing of work in place, as a result of negligence by the Contractor, shall be paid for by the party at fault.

3. The Work performed within each Section of the Specifications, unless otherwise indicated in the Plans and/or Specifications, includes all cutting, patching, and digging for work in that trade section required for proper accommodations of work of other trades. Execute such work with competent workers skilled in trade required for restoration. Contractor shall arrange and pay for cutting and patching required for installation of Contractor’s Work.

4. Contractor shall seal penetrations through all rated partitions, walls and floors with U.L. tested assemblies to provide and maintain a rating equal to or greater than the partition, wall or floor. In addition, Contractor shall seal penetrations through all floors to provide and maintain a watertight installation.

3.09 ASBESTOS ABATEMENT

A. In the event the Contractor encounters material reasonably believed to be asbestos at the Site, the Contractor shall immediately stop work in the area affected and report the condition to the Owner. If in fact the material is asbestos and has not been abated, the Contractor shall not resume the non-asbestos-related Work in the affected area until the asbestos has been abated.

B. The abatement action may be performed in any of three ways, as the Owner may decide. The Owner may perform the abatement by Owner’s own forces, or the Owner may contract with a third party to perform the abatement, or the Contractor may perform the abatement by an appropriate means acceptable to the Owner such as performing the Work through Contractor’s own employees if they are appropriately certified or by hiring an abatement subcontractor.

C. If the Contractor is to perform the abatement, the Owner and the Contractor will negotiate a change order in accordance with the contract terms relative to extra work. In such a case, the Owner specifically agrees that the cost of any special comprehensive general liability insurance that may be required relative to the abatement Work will be considered a direct cost of the extra work, on which, like the other direct costs, the Contractor will be allowed to add the applicable markup per the UGC.
3.10 CONTRACTOR LICENSURE

A. Contractor shall ensure that a Master Plumber licensed with the State of Texas directly supervises all plumbing Work. At least one plumber holding a State of Texas journeyman license shall be present at each Site during any plumbing Work.

B. Contractor shall ensure that Contractor's mechanical subcontractor is licensed with the State of Texas to install all HVAC Work.

C. Contractor shall ensure that a Master Electrician licensed with the State of Texas directly supervises all electrical Work. At least one electrician holding a State of Texas journeyman license shall be present at each Site involving Electrical Work.

3.11 SAFETY PRECAUTIONS AND PROGRAMS

A. MD Anderson Environmental Health and Safety (EH&S) has the authority to take intervening action in the event it deems patient, visitor, or staff of MD Anderson are in danger. Contractor shall adhere to requirements stated in Section 01 35 25 - Owner Safety Requirements.

B. Contractors shall familiarize themselves with, receive required training on, and abide by all policies and procedures of MD Anderson and any governmental body [i.e. NFPA, OSHA, EPA, TDLR (Texas Department of Licensing and Regulation), TCEQ (Texas Commission on Environmental Quality), etc.] having authority to control the manner and/or methods of completing the tasks contained in the Contract.

3.12 TEST, ADJUST, AND BALANCE

A. Owner may hire a Test, Adjust, and Balance firm. If Owner directly hires a Test, Adjust, and Balance firm, Contractor shall support the firm’s efforts to perform work as required.

3.13 MISCELLANEOUS

A. All gas lines that are involved with the Project must have ends capped with proper cap and sealant, even if valves are locked off.

B. Contractor shall install temporary equipment in such a manner that finish work will not be damaged by smoke, falling mortar, concrete, or other causes. Location and arrangement of temporary equipment shall be subject to the approval of the Owner’s Project Manager.

3.14 SITE AND AREA MAINTENANCE

A. A thorough cleanup of the Site and the Site’s surroundings is required no less than once per week or more often as directed by the Owner. Contractor shall be responsible to ensure that the debris and trash resulting from site operations are removed from the building and the property on a daily basis. Solid debris, such as brick bats, mortar and plaster droppings, may not be dumped on the grounds about the Site. All combustible material including scrap from lumber, crating, excelsior, paper, and similar types of trash shall be removed from the building site on a daily basis. Trash shall not to be allowed to accumulate.

B. The Contractor shall not allow food to be consumed or food wastes to accumulate at the Site in an effort to eliminate pests and insects.
C. Contractor shall be required to clean all streets of mud, dirt, dust, debris, and construction material produced during Contractor's construction activities on a daily basis. Contractor shall repair any damage to existing streets, parking, facilities, and any other area of the Site, including areas used for lay down or storage.

3.15 OPERATING AND MAINTENANCE MANUALS

A. Certain requirements of the UGC are supplemented by Section 01 77 00 – Project Closeout Procedures.

3.16 RECORD DOCUMENTS

A. Certain requirements of the UGC are supplemented by Section 01 77 00 – Project Closeout Procedures.

3.17 SHOP DRAWINGS AND SUBMITTALS

A. Certain requirements of the UGC are supplemented by Section 01 31 00 – Project Administration.

END OF SECTION 00 25 00
ATTACHMENT “A”
(to Owner’s Special Conditions)
MINIMUM WAGE RATE DETERMINATION

The University of Texas System is the contracting agency for this construction project. The following statute requires the contracting agency to specify the generally minimum rates of wages in contracts that are bid.

Government Code 2258
“Construction of Public Works in State and Municipal or Political Subdivisions; Prevailing Wage Rates to be maintained”
and
The Uniform General Conditions
for University of Texas System Building Construction Contracts

Pursuant to the requirements of this statute, we have determined that the following rates of wages are paid to various classifications of workers in the locality of this project.

Total hourly compensations to each worker must equal or exceed the minimum wage rates stated in the following attachment. Contributions by a worker toward health, pension, vacation, and the like are part of the worker’s pay; contributions by the employer are not. Any dollar amounts shown in columns for health, pension, and vacation may be paid either in cash or in kind. Workers in classifications where rates are not identified shall be paid not less than the general minimum rate of “laborer” for the various classifications of work therein listed.

All hours of work over 40 hours per week are overtime and will be compensated at the rate of 1 and ½ times the regular wage.

Trainees/helpers, where not otherwise specified above, may be compensated at a rate determined mutually by the worker and employer, commensurate with the experience and skill of the worker but a rate not less than 60% of the journeyman’s wage or less than the Laborers (General) rate. At no time shall a journeyman supervise more than two of apprentices, trainees or helpers. All apprentices/trainees/helpers shall be under the direct supervision of a journeyman working as a crew.
### The University of Texas System

**Office of Facilities Planning and Construction**

**Date:** December 31, 2009  
**Construction Type:** Building  
**Area:** Houston-Galveston

<table>
<thead>
<tr>
<th>Building Construction Trade Classification</th>
<th>Prevailing Wage Rate (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpenter</td>
<td>$14.38</td>
</tr>
<tr>
<td>Concrete Finisher</td>
<td>$14.63</td>
</tr>
<tr>
<td>Drywall/Ceiling Installer</td>
<td>$14.00</td>
</tr>
<tr>
<td>Electrician</td>
<td>$16.00</td>
</tr>
<tr>
<td>Elevator Mechanic</td>
<td>$23.61</td>
</tr>
<tr>
<td>Fire Proofing Installer</td>
<td>$13.88</td>
</tr>
<tr>
<td>Flooring Installer</td>
<td>$13.63</td>
</tr>
<tr>
<td>Glazier</td>
<td>$9.00</td>
</tr>
<tr>
<td>Heavy Equipment Operator</td>
<td>$13.25</td>
</tr>
<tr>
<td>Ironworker</td>
<td>$17.00</td>
</tr>
<tr>
<td>Laborer</td>
<td>$10.00</td>
</tr>
<tr>
<td>Light Equip Operator/Driver</td>
<td>$13.88</td>
</tr>
<tr>
<td>Mason/Bricklayer</td>
<td>$18.00</td>
</tr>
<tr>
<td>Painter</td>
<td>$14.25</td>
</tr>
<tr>
<td>Pipefitter</td>
<td>$14.87</td>
</tr>
<tr>
<td>Piping/Ductwork Insulator</td>
<td>$15.00</td>
</tr>
<tr>
<td>Plumber</td>
<td>$18.08</td>
</tr>
<tr>
<td>Roofer</td>
<td>$11.00</td>
</tr>
<tr>
<td>Sheetmetal Worker</td>
<td>$17.75</td>
</tr>
<tr>
<td>Sprinkler Fitter</td>
<td>$15.40</td>
</tr>
<tr>
<td>Tile Setter</td>
<td>$13.50</td>
</tr>
<tr>
<td>Waterproofer</td>
<td>$13.63</td>
</tr>
</tbody>
</table>

(1) **Wages shown are for entry level, minimum wages for each classification and do not include fringe benefits.**

Unlisted classifications needed for work not included within the scope of the classifications listed may not be added after award. The job classifications are not inclusive of all possible trades on the construction project.

It is the responsibility of the contractor to classify the worker in accordance with the published classifications, and demonstrate that workers are paid commensurate with determined rates.
FACILITIES PLANNED UTILITY OUTAGES POLICY

PURPOSE

The purpose of the policy is to define roles and responsibilities for requesting, coordinating, scheduling, and executing Planned Utility Outages.

POLICY STATEMENT

It is the policy of The University of Texas MD Anderson Cancer Center (MD Anderson) to establish and maintain a consistent process for requesting, coordinating, and executing Planned Utility Outages.

SCOPE

This policy applies to all MD Anderson workforce members and addresses MD Anderson-owned campus utilities systems and utility systems in rented or leased property under the responsibility of MD Anderson (e.g., life safety or fire alarm systems).

TARGET AUDIENCE

The target audience for this policy includes, but is not limited to, Facilities Management (FM) Project Managers, FM Operations and Maintenance (O&M) Staff, Contractors, and Stakeholders who request a Scheduled Utility Outage for:

- New construction.
- Renovation.
- Maintenance.

STRATEGIC VISION

Strategic Goal 7: Resources
Safeguard and enhance our resources.

DEFINITIONS

Contractor/Vendor: An individual or company hired to perform tasks on MD Anderson campuses but who does not receive wages directly from MD Anderson payroll.
Customer: Any MD Anderson workforce members or contractor who may be affected by the utility outage.
ATTACHMENT “B” TO OWNER’S SPECIAL CONDITIONS

**Energy Source:** Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

**Facilities Work Notifications:** A notification associated with a utility that a customer won’t notice or be impacted by an interruption.

**FM Onsite Outage Manager:** The Facilities Management (FM) workforce member responsible for managing the utility outage execution. This person must be listed in the official outage e-mail notification.

**FM Project Manager:** Facilities personnel who manage construction projects.

**FM Property Manager / Director:** The Facilities Management (FM) staff member responsible for managing a property/building and approving utility outages affecting its operations, excluding fire detection and fire suppression outages.

**Large Project:** A project that is estimated to have more than 50 outages during the course of the project.

**Mission Area:** Groups within Facilities Management that conduct technical investigations.

**O&M:** Operations and Maintenance

**Outage Coordinator:** Facilities Management personnel responsible for guiding MD Anderson-approved personnel through the procedures outlined in this policy.

**Outage Request:** A form that is used to collect pertinent information and to initiate the process for a planned interruption of the normal/expected operation environment of the facility.

**Outage Request System:** A system that is used to collect and capture all data associated with the requisition and completion of a planned utility outage.

**Planned Utility Outage:** A foreseen interruption of a utility flow to an end user that the end user will detect. Planned utility outages have a plan of action to accomplish specific tasks during the event.

**Requestor:** An MD Anderson workforce member, or his/her approved designee, who is authorized to input or generate utility outage requests in the utility outage system.

**Scheduled Utility Outage:** An outage is considered “scheduled” whenever the outage coordinator sends the final e-mail notification of approval, which includes the outage date/time and pertinent details.

**Shop Response:** A utility outage system document that is completed by the technical investigator and documents the impact and scope of the utility outage.

**Stakeholders:** Facilities Management staff, including contractors/vendors, who have participated in the planning, implementation, and execution of a utility outage.

**Technical Investigator:** A Facilities Management staff member who is responsible for investigating the impact of the outage request and preparing the Shop Response.

**Utility:** Any service provided by an outside source or manufactured in-house that facilitates building operations (e.g., gas, water, electricity, fire suppression water, fire alarm systems).
PROCEDURE

1.0 Request Outage

1.1 The Requestor will submit a completed Outage Request form through the Outage Request System.

Note: Refer to the Summary of Outage Scheduling Procedure Timeline (Appendix A) for typical timelines for executing outages in all MD Anderson buildings based on the scope of the outage, as determined by the Shop Response.

1.2 The Outage Coordinator will accept an Outage Request form and ensure that it is forwarded automatically to a Technical Investigator.

Note: A returned Outage Request form must be re-submitted as a new request.

1.3 Mission Areas must generate a work order and indicate “outage” as the work type for the associated equipment involved in the outage.

Note: Time and expenses must be assigned, as appropriate, to the work order.

2.0 Evaluate Outage

2.1 The Technical Investigator will determine the scope and impact of the Outage Request.

2.2 The Technical Investigator will review historical outages for the affected equipment before the field investigation.

2.3 The Technical Investigator will complete and submit the Shop Response in the Outage Request System.

2.4 Environmental Health and Safety (EH&S) will review and respond to all Outage Requests that may impact life safety systems (e.g., sprinkler, fire alarm, egress paths) and perform an Interim Life Safety Measures (ILSM) evaluation.

Note: The Outage Coordinator will perform an initial review for the terms “fire,” “emergency,” “egress,” and “life safety systems.” If any of these terms are present, the Outage Request will be forwarded to EH&S. The Final ILSM assessment and plan will be implemented by EH&S.

2.5 Work Notifications will be handled as follows:

A. The Outage Request will be turned into a Work Notification if, per the response of the Mission Area, the Customer will not detect or be affected by the outage.

B. The Outage Request will be turned into a Work Notification if the potential for impact to patients is low or non-existent.

C. The Mission Areas will complete an assessment of impacts on the Customer and building before indicating “No Impact” as a response to the Outage Coordinator.

D. If the Work Notification requires an interruption of utility service, an emergency outage will be implemented, per the proper procedure, to reduce risk to the Stakeholders and operations.

Examples of Utility Work Notifications:

- Hot Taps (i.e., Domestic Water).
ATTACHMENT “B” TO OWNER’S SPECIAL CONDITIONS

- Turning off Energy Source to equipment that is not in service.
- “Hot” Electrical Work (i.e., Installing breakers or bus plugs in a hot panel or riser).
- Utilities that have redundant sources (e.g., domestic water tanks, pumps, heat exchangers).
- Testing of systems (e.g., fire detection systems, fire pump tests, and annual Air Handler Unit (AHU) / fire alarm shutdown function testing).
- Load shed testing.
- Uninterrupted Power Supply (UPS) and equipment on UPS.

3.0 Coordinate Outage

3.1 The Outage Coordinator will review the Shop Response and establish the date and time for the outage after communicating and coordinating with the personnel impacted by the outage.

   Note: Project management business units are encouraged to provide dedicated contract staff for Large Projects to expedite outage coordination.

3.2 The Outage Coordinator will obtain approval from the FM Property Manager / Director for the final scheduled date and time of the outage.

   Note: EH&S will approve fire alarms and fire sprinkler systems.

3.3 The Outage Coordinator will send the final e-mail notification of the approved outage to Stakeholders and Customers.

   Note: This e-mail notification makes the outage an officially Scheduled Utility Outage. The FM Onsite Outage Manager must be designated in the e-mail.

3.4 The Requestor will notify Contractors/Vendors when the outage schedule is official and will provide them with all the pertinent information.

   Note: For a complex outage, it is recommended that the Requestor and Contractor do a pre-outage walk-through to confirm that the outage will occur as scheduled.

3.5 The Outage Coordinator(s), Mission Area, and Stakeholders will meet, as needed, to discuss outages, review requested and Scheduled Utility Outages, and review the status of all Shop Response requests.

4.0 Schedule and Execute Outage

4.1 FM and/or designated Contractor personnel will execute the outage.

4.2 The FM Property Manager / Director, or his/her designee, will approve the cancellation of the outage or the extension of the outage after it is executed.

4.3 The FM Onsite Outage Manager will notify the Facility Operations Center and the Outage Coordinator that the work has been completed, extended, or cancelled.

4.4 The Facility Operations Center or the Outage Coordinator will notify Stakeholders that the outage has been extended or cancelled.

4.5 The Facility Operations Center will log completed and cancelled outages in the shift log.
5.0 Cancellations

5.1 If situations require the outage to be cancelled or rescheduled, the FM Project Manager / FM Property Manager / Director or on-site manager is responsible for cancelling an outage after it has been approved and before it is executed.

5.2 The Facility Operations Center and Outage Coordinators will communicate cancellations as follows:

A. During Normal working hours:
   Outage Coordinator issues a cancellation notice under the direction of the FM Project Manager / FM Property Manager / Director or on-site manager.

B. After normal working hours:
   The Facility Operations Center issues a cancellation notice under the direction of the FM Project Manager / FM Property Manager / Director or on-site manager.

C. All Stakeholders will be notified of the cancellation, including those parties in O&M and EH&S who are involved in facilitating the outage.

ATTACHMENTS/LINKS

Summary of Outage Schedule Procedure Timeline – Appendix A.

RELATED POLICIES – (CONTACT OWNER’S PROJECT MANAGER)

Interim Life Safety Measures Policy (UTMDACC Institutional Policy #ADM0210).
Lockout/Tagout of Energized Equipment Policy (UTMDACC Institutional Policy #ADM0229).

JOINT COMMISSION STANDARDS / NATIONAL PATIENT SAFETY GOALS


“The hospital protects occupants during periods when the Life Safety Code is not met or during periods of construction.” Standard: LS.01.02.01. Comprehensive Accreditation Manual for Hospitals (CAMH), January 2012.

OTHER RELATED ACCREDITATION / REGULATORY STANDARDS

None.

REFERENCES

None.
## APPENDIX A
### SUMMARY OF OUTAGE SCHEDULING PROCEDURE TIMELINE
**REF, PCPF, AFCO, CPM**

This document illustrates a summary of the flow of action and a typical timeframe for executing outages in buildings with critical research, patient care, or administrative functions based on the level and scope of the outage.

<table>
<thead>
<tr>
<th>Step 1. REQUEST OUTAGE</th>
<th>WHO TAKES ACTION</th>
<th>BUSINESS DAYS FOR MOST OUTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete, submit Utilities Outage Shutdown request.</td>
<td>Requestor</td>
<td>0</td>
</tr>
<tr>
<td>Accept outage, or return outage to requestor.</td>
<td>AFCO Outage Coordinator</td>
<td>1</td>
</tr>
</tbody>
</table>

### Step 2. EVALUATE OUTAGE
Complete shop response. The shop response is used by the outage coordinator to determine the scope of outage impact.

<table>
<thead>
<tr>
<th>WHO TAKES ACTION</th>
<th>BUSINESS DAYS FOR LEVEL 1</th>
<th>BUSINESS DAYS FOR LEVEL 2</th>
<th>BUSINESS DAYS FOR LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Area Technical Investigator</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>AFCO Outage Coordinator</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Step 3. COORDINATE OUTAGE
Determine preliminary outage scheduled date using shop response and negotiate preliminary outage date with key stakeholders.

<table>
<thead>
<tr>
<th>WHO TAKES ACTION</th>
<th>BUSINESS DAYS FOR LEVEL 1</th>
<th>BUSINESS DAYS FOR LEVEL 2</th>
<th>BUSINESS DAYS FOR LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFCO Outage Coordinator</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Additional time may be required to: 1) obtain a consensus from key stakeholders who do not agree with requested outage date; 2) escalate to the FM property manager / director and/or FM AVP; and 3) receive final approval from FM property manager / director.

### Step 4. SCHEDULE AND EXECUTE OUTAGE
Notify all impacted personnel of approved outages via email with lead time for preparation of the outage. Conduct walk through of impacted area within 48 hours of outage, if feasible. Execute the outage.

<table>
<thead>
<tr>
<th>WHO TAKES ACTION</th>
<th>BUSINESS DAYS FOR LEVEL 1</th>
<th>BUSINESS DAYS FOR LEVEL 2</th>
<th>BUSINESS DAYS FOR LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFCO Outage Coordinator, Requestor, Contractor or FM Onsite Outage Manager</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

### ELAPSED BUSINESS DAYS for Step 1 - REQUEST OUTAGE TO Step 4 - SCHEDULE AND EXECUTION UTILITY OUTAGE.

<table>
<thead>
<tr>
<th>LEVEL 1</th>
<th>LEVEL 2</th>
<th>LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

### COMPLETE POST OUTAGE ACTIVITIES
- Facility Operations Center is notified about early, extended, cancelled and/or completed outages.
- Facility Operations Center notifies via email all impacted customers and key stakeholders about early, extended, and/or cancelled outages.
- Facility Operations Center notifies outage coordinator of outage completion and updates shift log.

<table>
<thead>
<tr>
<th>WHO TAKES ACTION</th>
<th>BUSINESS DAYS FOR LEVEL 1</th>
<th>BUSINESS DAYS FOR LEVEL 2</th>
<th>BUSINESS DAYS FOR LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM Onsite Outage Manager, Facility Operations Center</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION 024119 SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY
A. Section includes demolition and removal of selected portions of building or structure.

1.02 MATERIALS OWNERSHIP
A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.03 PREINSTALLATION MEETINGS
A. Predemolition Conference: Conduct conference at Project site.

1.04 INFORMATIONAL SUBMITTALS
A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of selective demolition activities with starting and ending dates for each activity.

1.05 FIELD CONDITIONS
A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
1. Maintain fire-protection facilities in service during selective demolition operations.

G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.06 WARRANTY

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

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

C. Inventory and record the condition of items to be removed and salvaged.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.

2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.03 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

C. Remove temporary barricades and protections where hazards no longer exist.

3.04 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
   2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
   4. Locate selective demolition equipment and remove debris and materials so as not
to impose excessive loads on supporting walls, floors, or framing.

5. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.05 CLEANING

A. Remove demolition waste materials from Project site and dispose of them in an landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19
SECTION 03 54 16 – HYDRAULIC CEMENT UNDERLAYMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.03 QUALITY ASSURANCE

A. Concrete Supplier: Regularly engaged in production of concrete floor underlayments.

B. Concrete Applicator: Regularly engaged and properly equipped for application of concrete floor underlayments, and as acceptable by aggregate manufacturer.

1.04 SUBMITTALS

A. Product Data:

1. Product data in the form of manufacturer's technical data, specifications, and installation instructions.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original undamaged packages or acceptable bulk containers.

B. Store packaged materials to protect them from elements or physical damage.

C. Do not use cement which shows indications of moisture damage, caking, or other signs of deterioration.

1.06 PROJECT CONDITIONS

A. Do not place concrete when ambient temperature is below freezing (32 degrees F, 0 degrees C).
PART 2 - PRODUCTS

2.01 GENERAL
   
   A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MATERIALS
   
   A. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch thick to feathered edges.

   1. Ardex, Inc. "K-15"
   2. Conspec Marketing and Mfg. Co. "Conflow"
   3. Dayton Superior Corp. "LevelLayer II"
   4. Euclid Chemical Co. "Flo-Top"
   5. L&M Construction Chemicals, Inc. "Levelex"
   6. Master Builders, Inc. "Pourcrete"
   7. Sonneborn, "SonoFlow".

   B. Primer: Provide manufacturer's recommended primer for each applicable substrate.

2.03 MIXING
   
   A. Provide batch type mechanical mixer for mixing topping material at the Project Site. Equip batch mixer with a suitable charging hopper, water storage tank, and a water-measuring device. Use only mixers which are capable of mixing aggregates, cement, and water into a uniform mix within specified time, and of discharging mix without segregation.

PART 3 - EXECUTION

3.01 INSTALLATION
   
   A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

   B. All installation shall be in accordance with manufacturer's published recommendations.

   C. Place underlayment in accordance with manufacturer's instructions, using equipment and procedures to avoid segregation of mix and loss of air content. Deposit and screed in a continuous operation until an entire panel or section of floor area is completed. Do not vibrate or work mix except for screeding or floating.
3.02 PLACING

A. Spread topping mixture evenly over prepared base to the required elevation and strikeoff. Use highway straightedge, bull float, or darby to level surface. After the topping has stiffened sufficiently to permit the operation, and water sheen has disappeared, float the surface at least twice to a uniform sandy texture. Restraighten where necessary with highway straightedge. The surface shall achieve an FF20/FL17 tolerance when tested in accordance with ASTM E 1155. Uniformly slope surface to drains.

1. Where joints are required, construct to match and coincide with joints in base slab. Provide other joints as shown.

B. After floating, begin first trowel finish operation using power driven trowels. Continue troweling until surface is ready to receive final troweling. Begin final troweling when a ringing sound is produce as trowel is moved over surface.

C. Continue final trowel operation to produce finished surface free of trowel marks, uniform in texture and appearance, achieving an FF25/FL20 when tested in accordance with ASTM E 1155.

3.03 CURING AND PROTECTION

A. Cure and protect topping applications and finishes as specified by the topping manufacturer.

3.04 PERFORMANCES

A. Failure of concrete topping to bond to substrate (as evidenced by a hollow sound when tapped), or disintegration or other failure of topping to perform as a floor finish, will be considered failure of materials and workmanship. Repair or replace toppings in areas of such failures, as directed.

END OF SECTION 03 54 16
SECTION 07 84 13 – PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

   A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

   B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

   A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

   B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

   C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.03 QUALITY ASSURANCE

   A. Arrange for work to be performed by an experienced installer who is certified, licensed, FM Approved in accordance with FM 4991, Certified by UL as a Qualified Contractor, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products per specified requirements. Installer shall have a minimum of three years experience in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project. If requested, provide a list of past projects for verification of required experience.

   B. Materials shall have been tested to provide fire rating equal to that of the construction, within the actual depth and thickness of the construction.

1.04 SUBMITTALS

   A. Product Data:

      1. Submit a complete listing of all manufacturers, products, model numbers, and designs proposed for use in the Work of this Section.

   B. Shop Drawings:

      1. Show each condition requiring penetration seals indicating proposed UL systems materials, anchorage, methods of installation, and actual adjacent construction.
2. Submit UL illustration of each proposed system indicating manufacturer approved modifications.

C. Certificate: Submit installer’s qualification certificates, or letters from firestopping manufacturer attesting to installer’s successful completion of training.

D. Record Documents:

1. Maintain two copies of all shop drawings, product data, and samples, manufacturer's specifications, recommendations, installation instructions, and maintenance data at the Project Site.

2. At Project Closeout, turn over both copies to the Architect who will transmit one copy to the Owner.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled unopened containers, identified with brand, type, grade and UL label where applicable.

1.06 PROJECT CONDITIONS

A. Verify existing conditions and substrates before starting Work. Correct unsatisfactory conditions before proceeding.

B. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

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

1. Hilti Firestop Systems.

2. 3M, Electrical Products Division, St. Paul, Minnesota.

3. Metacaulk; Rectorseal Corp., Houston, Texas


5. United States Gypsum Company.
2.03 MATERIALS

A. Provide materials classified by UL to provide fire barrier equal to time rating of construction being penetrated.

B. Provide asbestos free materials that comply with applicable Codes and have been tested in accordance with UL 1479 or ASTM E 814.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Install penetration seal materials in accordance with printed instructions of the UL Building Materials Directory and in accordance with manufacturer's instructions.

D. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

E. Remove damming materials after curing if made of other than fire resistant materials.

F. Protect materials from damage on surfaces subject to traffic.

G. Environmental Requirements:
   1. Keep flammable materials away from sparks or flame.
   2. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
   3. Maintain minimum 40 degrees F temperature of substrates for 24 hours before, during, and 24 hours after application of firestopping materials.

3.03 FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable authorities having jurisdiction.

C. Perform under this Section patching and repairing of firestopping caused by cutting or penetration by other trades.
3.04 ADJUSTING AND CLEANING

A. Clean up spills of liquid components with solvent.

B. Neatly cut and trim materials with sharp knife or blade as required.

C. Remove materials and debris, leaving area in undamaged, clean condition.

END OF SECTION 07 84 13
SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Urethane joint sealants.
2. Mildew-resistant joint sealants.
3. Latex joint sealants.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.
B. Samples: For each kind and color of joint sealant required.
C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.

1.04 INFORMATIONAL SUBMITTALS

A. Field-adhesion-test reports.
B. Sample warranties.

1.05 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Failures include joint sealant installations where failure is due to adhesive failure.
2. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish elastomeric joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Failures include joint sealant installations where failure is due to cohesive failure.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 JOINT SEALANTS, GENERAL

A. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.

2.02 URETHANE JOINT SEALANTS

A. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
   a. BASF Construction Chemicals - Construction Systems; Sonolastic SL 1.
   b. Pecora Corporation; NR-201.
   c. Sherwin-Williams Company (The); Stampede 1SL.

2.03 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
   a. Dow Corning Corporation; 786-M White.
   b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
   c. Tremco Incorporated; Tremsil 200.

2.04 LATEX JOINT SEALANTS

   A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

      a. BASF Construction Chemicals - Construction Systems; Sonolac.
      b. Pecora Corporation; AC-20.
      c. Sherwin-Williams Company (The); 950A Siliconized Acrylic Latex Caulk, White or PowerHouse Siliconized Acrylic Latex Sealant.
      d. Tremco Incorporated; Tremflex 834.

2.05 JOINT-SEALANT BACKING

   A. Cylindrical Sealant Backings: ASTM C 1330, of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

   1. Provide any of the following types, as approved in writing by joint-sealant manufacturer for joint application indicated:

      a. Type C (closed-cell material with a surface skin).
      b. Type O (open-cell material).
      c. Type B (bicellular material with a surface skin).

   B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.06 MISCELLANEOUS MATERIALS

   A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

   B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.
C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove laitance and form-release agents from concrete.
   2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.02 INSTALLATION OF JOINT SEALANTS

A. General: Comply with ASTM C 1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration
indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

1. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.03 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
   a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.


B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.04 JOINT-SEALANT SCHEDULE

A. Interior joints in horizontal traffic surfaces.

1. Joint Locations:
   a. Control and expansion joints in tile flooring.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement except as otherwise indicated.

1. Joint Locations:
   a. Perimeter joints between interior wall surfaces and frames of interior doors.
   b. Other joints as indicated on Drawings.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.
   c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00
SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.03 QUALITY ASSURANCE

A. Provide doors, panels, and frames complying with the NAAMM Standard HMMA 861-87, “Guide Specifications for Commercial Hollow Metal Doors and Frames,” except as otherwise specified in this Section.

B. Provide custom steel doors and frames manufactured by a single firm specializing in the production of this type of work, unless otherwise acceptable to the Architect and Owner.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide manufacturer’s certification that doors conform to all standard construction requirements of tested and labeled fire-rated door assemblies except for size.

2. Temperature Rise Rating: At stairwell enclosures, provide doors that have a temperature rise rating of 450 degrees F (232 degrees C) maximum in 30 minutes of fire exposure.

1.04 SUBMITTALS

A. Product Data:

1. Product data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles, and finishes.

B. Shop Drawings:
1. Submit drawings for fabrication and installation of custom steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections.

   a. Coordinate submittals with other doors, frames, and hardware and use the same “opening number identification” as given on the Contract Drawings and the Door Schedule.

   1) Submittals not using the numbering identification shown on Contract Drawings and Schedules will be rejected.

2. Label Construction Certification: For door assemblies required to be fire-rated and that exceed limitations of labeled assemblies, submit manufacturer’s certification that each door and frame assembly has been constructed to conform to design, materials and construction equivalent to requirements for labeled construction.

C. Record Documents:

1. Provide record approved submittals and warranties.

1.05 DELIVERY, STORAGE AND HANDLING

A. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to the Architect; otherwise remove and replace damaged items as directed.

B. Store doors and frames at the building Site under cover. Place units on minimum 4-inch high wood blocking. Avoid the use of nonvented plastic or canvas shelters that could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Provide ¼-inch spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include:

1. Amweld Building Products, Inc.
2. Ceco Door Products.
3. Curries Manufacturing Inc.
4. Pearland Industries.
5. Fenestra Corp.
2.03 MATERIALS

A. Hot-Rolled Steel Sheets: ASTM A 569/A 569M, CS (Commercial Steel), Type B; free of scale, pitting or surface defects; pickled and oiled.

B. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, CS (Commercial Steel), Type B.

C. Metallic-Coated (Galvanized) Steel Sheets: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (AZ180) zinc-iron-alloy (galvannealed) coating.

D. Stainless-Steel Sheets: ASTM A 666, austenitic stainless steel, Type 304 or Type 316.

E. Supports and Anchors: Fabricate of not less than 16-gage sheet metal. Galvanize after fabrication units to be built into exterior walls, complying with ASTM A 153, Class B.

F. Inserts, Bolts, and Fasteners: Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls, complying with ASTM A 153, Class C or D as applicable.

G. Shop-Applied Paint: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as base for specified finish paints on steel surfaces.

2.04 FABRICATION, GENERAL

A. Fabricate hollow metal units to be rigid, neat in appearance, and free from defects, warp, or buckle. Accurately form metal to required sizes and profiles. Wherever practicable, fit and assemble units in the manufacturer’s plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at the Project Site. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Metallic filler to conceal manufacturing defects is not acceptable.

1. Interior Doors: Minimum 18-gage face sheets.

2. Exterior Doors: Minimum 16-gage face sheets.

B. Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

C. Sound-Rated (Acoustical) Assemblies: Wherever shown or scheduled, provide door and frame assemblies that have been fabricated as sound-reducing type, tested in accordance with ASTM E 90, and classified in accordance with ASTM E 413.

1. Unless otherwise indicated, provide acoustical assemblies with sound ratings of STC 33 or better.
D. Prepare doors and frames to receive finish hardware, including cutouts, reinforcing, mortising, drilling, and tapping in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A 115 series Specifications for door and frame preparation for hardware.

1. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at Project Site.

2. Locate finish hardware as shown on final Shop Drawings, or if not shown, in accordance with “Recommended Locations for Builder’s Hardware for Custom Steel Doors and Frames,” published by Door and Hardware Institute.

E. Clean, treat, and paint exposed surfaces of steel doors and frames, including galvanized surfaces, but excluding stainless steel surfaces.

1. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.

2. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC-PT2), hot phosphate solution (SSPC-PT4), or basic zinc chromate-vinyl butyryl solution (SSPC-PT3).

3. Apply shop coat of prime paint within time limits recommended by pretreatment manufacturer. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.

F. Provide stops and moldings around solid, glazed, and louvered panels where indicated.

1. Form fixed stops and moldings integral with frame, unless otherwise indicated.

2. Provide removable stops and moldings where indicated or required, formed of not less than 20-gage steel sheets matching steel of frames. Secure with countersunk flat or oval head machine screws spaced uniformly not more than 12 inches on center. Form corners with butted hairline joints.

3. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated.

2.05 DOORS

A. Provide flush design doors, 1-¾ inches thick, seamless hollow construction.

1. For single-acting swing doors, bevel both vertical edges 1/8 inch in 2 inches. For double-acting swing doors, round vertical edges with 2-1/8 inch radius.

2. Unless otherwise required for acoustical or thermal doors, provide filler of fiberboard, mineral-wool board, or other insulating material solidly packed full door height to fill voids between inner core reinforcing members.

3. Reinforce doors with rigid tubular frame where stiles and rails are less than 8 inches wide. Form tubular frame with 16-gage steel, welded to outer sheets.
4. Provide internal core constructed of galvanized, stretcher-leveled steel sheets not less than 18-gage, vertically reinforced with galvanized sheet steel sections not less than 22 gage, spaced 6 inches on center, extending full height of door and spot welded to both face sheets at not more than 5 inches on center.

a. Continuous truss-form reinforcement of 28-gage galvanized steel may be provided in lieu of spaced steel sections. Spot weld truss-form reinforcement 3 inches on center vertically and horizontally over entire core surface on both sides.

5. Reinforce tops and bottoms of doors with galvanized, 18-gage, horizontal steel channels, welded continuously to core faces. For exterior stainless steel doors, close top and bottom edges to provide weather seal.

B. Painted Exterior Doors: Fabricate exterior doors of two outer, galvanized, stretcher-leveled steel sheets not less than 16-gage. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges, except around glazed or louvered panel inserts. Provide weep-hole openings in the bottom of doors to permit escape of entrapped moisture.

1. Reinforce inside of doors with vertical galvanized sheet steel sections not less than 22-gage. Space vertical reinforcing 6 inches on center and extend full door height. Spot weld at not more than 5 inches on center to both face sheets.

a. Continuous truss-form inner core of 28-gage galvanized sheet steel reinforcing may be provided as inner reinforcement, in lieu of above. Spot weld truss-form reinforcement 3 inches on center vertically and horizontally over entire surface of both sides.

2. Reinforce tops and bottoms of doors with 16-gage horizontal galvanized sheet channels welded continuously to outer sheets. Close top and bottom edges to provide flush, waterproof weather seal, as integral part of door construction or by addition of inverted steel channels.

C. Painted Interior Doors: Fabricate interior doors of two (2) outer, cold-rolled, stretcher-leveled steel sheets not less than 18-gage. Construct doors with smooth, flush surfaces, without visible joints or seams on exposed faces or stile edges, except around glazed or louvered panel inserts.

1. Reinforce inside of doors with vertical, hot-rolled, not less than 22-gage steel sections. Space vertical reinforcing 6 inches on center and extend full door height. Spot weld at not more than 5 inches on center to both face sheets.

a. Continuous truss-form inner core of 28-gage sheet metal reinforcing may be provided as inner reinforcement in lieu of above. Spot weld truss-form reinforcement 3 inches on center vertically and horizontally over entire surface of both sides.

2. Reinforce tops and bottoms of doors with 18-gage, horizontal steel channels, welded continuously to outer sheets.

D. Finish Hardware Reinforcement: Minimum gages of steel reinforcing plates for the following hardware:
1. Hinges and Pivots: 7-gage thick by 1-½ inches wide by 6 inches longer than hinge, secured by not less than six (6) spot welds.

2. Lock Face, Flush Bolts, Closers, and Concealed Holders: 12-gage.

3. All Other Surface-Mounted Hardware: 16-gage.

2.06 FRAMES

A. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, continuously welded full depth and width of frame. Knock-down type frames are not acceptable.

1. Form frames of minimum 14-gage galvanized steel sheets for exterior, and either cold or hot-rolled sheet steel of the following minimum gages for interior:
   a. Openings up to and including 4 feet 0 inches wide: 16-gage.
   b. Openings over 4 feet 0 inches wide: 14-gage.

2. Form frames of stainless steel sheets with #4 polish for openings indicated to receive stainless steel doors.

B. Finish Hardware Reinforcement: Minimum gages of steel reinforcing plates for the following hardware:

1. Hinges and Pivots: 7-gage thick by 1-½ inches wide by 6 inches longer than hinge, secured by not less than six (6) spot welds.


C. Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.

1. Provide false head member to receive lower ceiling where frames extend to finish ceilings of different heights.

D. Head Reinforcing: Where installed in masonry, leave vertical mullions in frames open at top for grouting.

E. Jamb Anchors: Furnish jamb anchors as required to secure frames to adjacent construction, formed of not less than 18-gage galvanized steel.

1. Masonry Construction: Adjustable, flat, corrugated, or perforated, t-shaped to suit frame size, with leg not less than 2 inches wide by 10 inches long. Furnish at least two (2) anchors per jamb up to 7 feet 6 inches in height; Four (4) anchors up to an 8 feet 0 inches in jamb height; one (1) additional anchor for each 24 inches or fraction thereof over 8 feet 0 inches in height.
2. Metal Stud Partitions: Insert type with notched clip to engage metal stud, welded to back of frames. Provide at least four (4) anchors for each jamb for frames up to 7 feet 6 inches height; five (5) anchors up to 8 feet 0 inches in jamb height; one (1) additional anchor each 24 inches or fraction thereof over 8 feet 0 inches in height.

3. In-Place Concrete or Masonry: Anchor frame jambs with minimum 3/8 inch concealed bolts into expansion shields or inserts at 6 inches from top and bottom and 26 inches on center, unless otherwise shown. Reinforce frames at anchor locations. Except for fire-rated openings, apply removable stop to cover anchor bolts unless otherwise indicated.

F. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of not less than 14-gage galvanized steel sheet, as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.

2. Separate Topping Concrete Slabs: Adjustable type with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

G. Head Anchors: Provide two anchors at head of frames exceeding 42 inches wide for frames mounted in steel stud walls.

H. Head Strut Supports: Provide 3/8 inch by 2 inch vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members in compliance with UL 63.

I. Structural Reinforcing Members: Provide as part of frame assembly, where indicated at mullions, transoms, or other locations that are to be built into frame.

J. Head Reinforcing: For frames over 4 feet 0 inches wide in masonry wall openings, provide continuous steel channel or angle stiffener, not less than 12-gage for full width of opening, welded to back of frame at head.

K. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.

L. Rubber Door Silencers: Except on weather stripped doors, drill stop in strike jamb to receive three (3) silencers on single-door frames add drill head jamb stop to receive four (4) silencers on double-door frames. Install plastic plugs to keep holes clear during construction.

M. Plaster Guards: Provide 26-gage steel plaster guards or dust cover boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

2.07 STEEL FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP1, “Solvent Cleaning”; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 3, “Power Tool Cleaning,” or SSPC-SP 6/NACE No. 3, “Commercial Blast Cleaning.”
B. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).

C. Galvanized Steel Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.


D. Galvanized Steel Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).

E. Shop Primer: Manufacturer’s or fabricator’s standard, fast-curing, corrosion-inhibiting, lead and chromate-free, universal primer complying with ANSI A224.1 acceptance criteria; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

2.08 STAINLESS STEEL FINISHES

A. Finish designations prefixed by AISI conform with the system established by the American Iron and Steel Institute for designating finishes for stainless steel sheet.

B. Unless otherwise indicated, provide Bright, Directional Polish, AISI No. 4 finish on all stainless steel items.

1. On doors, align direction of polish marks to be vertical.

2. On frames, align direction of polish marks to be vertical on both jambs and head.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, and referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install frames and accessories in accordance with Shop Drawings, manufacturer’s data, and as herein specified.

1. Setting Masonry Anchorage Devices: Provide masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.

   a. Set anchorage devices opposite each anchor location, in accordance with details on final Shop Drawings and anchorage device manufacturer’s instructions. Leave drilled holes rough, not reamed, and free from dust and debris.
2. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on final Shop Drawings.

D. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

1. At in-place concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.

2. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.

3. Make field splices in frames as detailed on final Shop Drawings, welded and finished to match factory work.

4. Remove spreader bars only after frames or bucks have been properly set and secured.

E. Install doors after adjacent work is completed and dry. Do not install doors until closers or stops and holders can be installed simultaneously for protection of doors.

F. Fit non-fire rated doors accurately in their respective frames, with the following clearances:

   3. Bottom: 3/8 inch, where no threshold or carpet.
   4. Bottom: 1/8 inch, at threshold or carpet.

G. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.

3.02 ADJUST AND CLEAN

A. Final Adjustments: Check and readjust operating hardware items just prior to final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed or otherwise unacceptable.

B. Prime Coat Touch-Up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

   1. Repair installed dented and damaged units to new condition by filling with automotive body putty.
   2. Fill exposed countersunk anchor screws in countersunk screw holes with automotive body putty after units are installed in place.
   3. Grind puttied areas smooth, true and even with surrounding surfaces. Repaint puttied areas with one additional coat of the specified primer before proceeding with field painting.

END OF SECTION 08 11 13
SECTION 08 71 11 – FINISH HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same Sections as the doors and door frames on which they are installed.

1. Provide cylinders for operation of lock mechanisms furnished as part of the Work of other Sections such as entrance doors, rolling doors and grilles, etc.

   a. Provide cylinders keyed to building system and with finish to match adjacent surfaces.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed door hardware installation similar in material, design, and extent to that indicated for this Project and whose Work has resulted in construction with a record of successful in-service performance.

B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.

C. Electrified Door Hardware Supplier Qualifications: An experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this Project, whose Work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.
1. Engineering Responsibility: Prepare data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer’s standard units in assemblies similar to those indicated for this Project.

D. Fire Rated Openings: Provide door hardware for fire rated openings that comply with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire rated door and door frame labels.

E. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

1.05 SUBMITTALS

A. Product Data:

1. Include installation details, material descriptions, dimensions of individual components, profiles, and finishes.

B. Shop Drawings:

1. Details of electrified door hardware, indicating the following:

   a. Wiring Diagrams: Detail wiring for power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

      1) System schematic.

      2) Point-to-point wiring diagram.

      3) Riser diagram.

      4) Elevation of each door.

   2. Details of interface between electrified door hardware and fire alarm, access control, security, and building control system.

   3. Door Hardware Schedule:

      a. Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedules with doors, frames, and related Work to ensure proper size, thickness, hand, function, and finish of door hardware.

      b. Format: Comply with scheduling sequence and vertical format in DHI’s “Sequence and Format for the hardware schedule.

      c. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door opening.
d. Use same identifying “set numbers” given in each Section. Coordinate submittal with doors and frames submittals and use same “opening number” identification as given on Drawings and in the Door Schedule.

e. Submittals not using numbering identification system shown on Drawings and Schedules will be rejected.

f. Content: include the following information:

1) Type, style, function, size, and finish of each hardware item.

2) Name and manufacturer of each item.

3) Fastenings and other pertinent information.

4) Location of each hardware set, cross referenced to indications on Drawings both on floor plans and in door and frame schedule.

5) Explanation of all abbreviations, symbols, and codes contained in schedule.

6) Mounting locations for hardware.

7) Door and frame sizes and materials.

8) Keying information.

9) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.

g. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other Work that is critical in the Project construction schedule. Include with schedule the product data, samples, Shop Drawings of other Work affected by door hardware, and other information essential to the coordinated review of schedule.

4. Keying Schedule: Prepared by or under the supervision of supplier, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

5. Templates for doors, frames, and other specified items to be factory prepared for the installation of door hardware. Check Shop Drawings of other Work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Samples:

1. Samples of each type of exposed hardware unit in finish indicated and tagged with full description for coordination with schedule. Submit samples prior to submission of final hardware schedule.

D. Record Documents:

1. Provide record approved product data, shop drawings, samples, and warranties.
1.06 COORDINATION

A. Coordinate the Work of this Section with Work of other sections that interface with hardware.

B. Furnish templates for doors, frames, and other Work specified to be factory prepared for the installation of door hardware to the appropriate trades. Check Shop Drawings of other Work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.07 HARDWARE ALLOWANCE

A. Selection and Ordering: Furnish door hardware as selected by Architect and in such quantities as provided for under Division 01 and other general provisions of the Contract.

B. Door hardware supplier's responsibilities shall be as follows:

1. Submittals: Submit through Contractor required product data, final hardware schedule, separate keying schedule, and samples as specified in this Section, unless otherwise indicated.

2. Construction Schedule: Inform Contractor promptly of estimated times and dates that will be required to process submittals, to furnish templates, to deliver hardware, and to perform other Work associated with furnishing door hardware for purposes of including this data in construction schedule. Comply with this schedule.

3. Coordination and Templates: Assist Contractor as required to coordinate hardware with other Work in respect to both fabrication and installation. Furnish Contractor with templates and deliver hardware to proper locations.

4. Product Handling: Package, identify, deliver, and inventory door hardware specified in this Section.

5. Discrepancies: Based on requirements indicated in Contract Documents in effect at time of door hardware selection, furnish types, finishes, and quantities of door hardware, including fasteners, and Owner's maintenance tools required to comply with specified requirements and as needed to install and maintain hardware. Furnish or replace any items of door hardware resulting from shortages and incorrect items at no cost to the Owner or Contractor. Obtain signed receipts from Contractor for all delivered materials.

C. Contractor's responsibilities shall be as follows:

1. Submittals: Coordinate and process submittals for door hardware in same manner as submittals for other Work.

2. Construction Schedule: Cooperate with door hardware supplier in establishing scheduled dates for submittals and delivery of templates and door hardware. Incorporate in construction schedule the times and dates related to furnishing hardware by door hardware supplier.

3. Coordination: Coordinate door hardware with other Work. Furnish hardware supplier or manufacturer with Shop Drawings of other Work where required or requested. Verify completeness and suitability of hardware with supplier.
4. Product Handling: Provide secure lock up for hardware delivered to the Site. Inventory hardware jointly with representative of hardware supplier and issue signed receipts for all delivered materials.

5. Installation Information: The general types and approximate quantities of hardware required for this Project are indicated at the end of this Section in order to establish Contractor's costs for installation and other Work not included in allowance.

6. No adjustments in Contract sum will be made for costs other than those covered by the allowances for subsequent increases or decreases in quantity of one or more hardware types that do not exceed 5 percent.

1.08 PRODUCT HANDLING

A. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

B. Deliver individually packaged door hardware items promptly to place of installation (shop or Project Site).

1.09 MAINTENANCE

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

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 SCHEDULED HARDWARE

A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of Part 3 of this Section. Products are identified by using hardware designation numbers of the following:

1. Manufacturer's Product Designations: The product designation and name of one (1) manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one (1) manufacturer is specified for each hardware type, the comparable product of one (1) of the other manufacturers that complies with requirements.

2. ANSI/BHMA designations used elsewhere in this Section or in schedules to describe hardware items or to define quality or function are derived from the following standards. Provide products complying with these standards and requirements specified elsewhere in this Section.


c. Exit Devices: ANSI/BHMA A156.3.
d. Door Controls Closers: ANSI/BHMA A156.4.
e. Auxiliary Locks and Associated Products: ANSI/BHMA A156.5.
g. Template Hinge Dimensions: ANSI/BHMA A156.7.
h. Door Controls Overhead Holders: ANSI/BHMA A156.8.
i. Interconnected Locks and Latches: ANSI/BHMA A156.12.
m. Auxiliary Hardware: ANSI/BHMA A156.16.
o. Materials and Finishes: ANSI/BHMA A156.18.

2.03 MATERIALS AND FABRICATION

A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire rated labels and as otherwise acceptable to Architect.

1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

D. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru bolts for installation where bolt head or nut on opposite face is exposed in other Work unless their use is the only means of reinforcing the Work adequately to fasten the hardware securely. Where thru bolts are used as a means of reinforcing the Work, provide sleeves for each thru bolt or use sex screw fasteners.
2.04 HINGES, BUTTS, AND PIVOTS

A. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template produced units.

B. Screws: Provide Phillips flat head screws complying with the following requirements:
   1. For metal doors and frames install machine screws into drilled and tapped holes.
   2. For wood doors and frames install wood screws.
   3. For fire rated wood doors install #12 x 1 1/4 inch, threaded to the head steel wood screws.
   4. Finish screw heads to match surface of hinges or pivots.

C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   2. Out Swing Corridor Doors with Locks: Non-removable pins.
   3. Interior Doors: Non-rising pins.
   4. Tips: Flat button and matching plug, finished to match leaves, except where hospital tip (HT) indicated.

D. Number of Hinges: Provide number of hinges indicated but not less than three (3) hinges per door leaf for doors 90 inches or less in height and one (1) additional hinge for each 30 inches of additional height.
   1. Fire Rated Doors: Not less than three (3) hinges per door leaf for doors 90 inches or less in height with same rule for additional hinges.

E. Continuous Hinges:
   1. Hinge to be manufactured of 6063-T6- aluminum alloy with anodized finishes (painted finishes available on entire hinge or gear cap only).
   2. Door and frame leaves to be machined, anodized and assembled as a matched pair. Door and frame leaves to be anodized after all machining and drilling processes are complete.
   3. All hinge profiles shall be manufactured to template screw locations, with standard duty and heavy duty hole patterns identical as to number and placement of holes. All hinge profiles to be manufactured to template bearing locations, with standard duty bearing configurations of 5-1/8 inch spacing with a minimum of sixteen (16) bearings; and heavy duty at 2-9/16 inch spacing with a minimum of thirty-two (32) bearings.
   4. Hinge leaves to be extruded at a uniform 1/8 inch thickness from pivot point to outside edge of hinge leaf. Uncut hinges shall be non-handed and shall be paintless assembly of three (3) interlocking extrusions applied to the full height of the door and frame without mortising.
5. Vertical door loads shall be carried on chemically lubricated thermoplastic thrust bearings. The door and frame leaves shall be continuously geared together for the entire hinge length and this relationship secured with a full length cover channel so that the hinge will operate through a full 180 degrees.

6. All rotating areas of the gear cap and geared leaves shall have a permanent lubrication which is factory applied along the full length of the hinge, and the lubricant shall last the life of the hinge with no additional maintenance required. Fasteners supplied shall be 410 stainless steel, brite hardened and plated.

2.05 LOCK CYLINDERS AND KEYING

A. Refer to Section 01 78 46 for Maintenance Material Requirements.

2.06 LOCKS, LATCHES, AND BOLTS

A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.

1. Provide flat lip strikes for locks with 3 piece, antifriction latchbolts as recommended by manufacturer.

2. Provide extra long strike lips for locks used on frames with applied wood casing trim.

3. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.

4. Provide dust proof strikes for foot bolts, except where special threshold construction provides non recessed strike for bolt.

5. Provide roller type strikes where recommended by manufacturer of the latch and lock units.

6. Provide standard (open) strike plates for interior doors of residential units where wood door frames are used.


1. Provide 1/2 inch minimum throw of latch for other bored and preassembled types of locks and 3/4 inch minimum throw of latch for mortise locks. Provide 1 inch minimum throw for all dead bolts.

C. Flush Bolt Heads: Minimum of 1/2 inch diameter rods of brass, bronze, or stainless steel with minimum 12 inch long rod for doors up to 7 feet 0 inches in height. Provide longer rods as necessary for doors exceeding 7 feet 0 inches in height.

D. Exit Device Dogging: Except on fire rated doors where closers are provided on doors equipped with exit devices, equip the units with keyed dogging device to keep the latch bolt retracted, when engaged.

E. Rabbeted Doors: Where rabbeted door stiles are indicated, provide special rabbeted front on lock and latch units and bolts.
2.07 PROGRAMMABLE/ELECTRIFIED LOCKING DEVICES

A. Programmable Locking Device:

1. Lock shall be heavy-duty cylindrical type, with a 2-3/4 inches backset supplied with a ½ inch throw latchbolt as standard. Chassis shall accommodate standard 161 cylindrical lock prep for 1-3/4 inch doors as standard, with 1-3/8 inches to 2-3/4 inch thick doors in 1/8 inch increments available. Locksets shall be provided from the factory with the appropriate handing.

2. Outside and inside levers shall operate independently of each other. Lock shall use patented, clutch mechanism to deter vandalism and maximize durability. Disablement of secured levers shall not permit latchbolt retraction from secure side while allowing emergency egress.

3. The lock will be furnished with the Classroom and Storeroom function which is: The outside lever is normally locked. The inside lever is always free. The unit may be momentarily unlocked with an approved Normal access credential. The unit may be maintained unlocked by using a Toggle access credential.

4. Emergency mechanical key override utilizes a 1-1/4 inch mortise cylinder with standard straight cam.

5. Outside escutcheon shall contain an integrated 6-button keypad.

6. Visual red and green LED indicators shall indicate activation, operational system status, system error conditions and low power conditions.


B. Electrified Locking Device: A security platform that combines mechanical hardware with the ability to monitor door openings with Owner’s existing access control panel and software.

1. Complete monitoring of door from the lockset.

2. Panel interface board connects to third party access control panel.

3. Available in proximity or magnetic stripe.

4. Simplified request to exit component contained in the inside trim.

5. Industry standard HID Prox coordinates with Owner’s existing credential.

6. UL tested for use on fire doors up to and including 3 hours. ANSI Grade 1.

2.08 EXIT DEVICES

A. Exit Devices shall be touchpad type, fabricated of bronze, brass, stainless steel, or aluminum, and plated to the standard architectural finishes to match the balance of door hardware.
B. All exit devices shall incorporate a fluid damper, which decelerates the touchpad on its return stroke and eliminates noise associated with exit device operation. Touchpad shall extend a minimum of one half of the door width. All latchbolts to be deadlatching type, with a self-lubrication coating to reduce wear. Mechanism case and end-cap will be 0.140-gauge attachment to door. Touchpad shall match exit device finish, and shall be stainless steel for US26, US26D, US28, US32, and US32D finishes. Only compression springs will be used in devices, latches, and outside trims or controls.

C. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.

D. Lever trim for exit devices shall be vandal-resistant type, which will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.

E. All exit devices shall be of one manufacturer. No deviation will be considered.

F. All trim shall be thru-bolted to the lock stile case. Lever design to match locksets.

G. Surface vertical rod devices shall be UL labeled for fire door applications without the use of bottom rod assemblies. Where bottom rods are required for security applications, the devices shall be UL labeled for fire door applications with rod and latch guards by the device manufacturer.

2.09 CLOSERS AND DOOR CONTROL DEVICES

A. Access-Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped, provide adjustable units complying with ADA and ANSI A-117.1 provisions for door opening force.

1. At interior doors, adjust closers for door opening force not to exceed 5 foot-pounds of force. If a door has a closer, then the sweep period of the closer shall be adjusted so that from an open position of 90 degrees, the time required to move the door to a position of 12 degrees from the latch is five (5) seconds minimum.

2. At exterior doors, adjust closers for door opening force not to exceed 8.5 foot-pounds of force.

3. Where parallel arms are indicated for closers, provide closer unit one (1) size larger than recommended for use with standard arms.

B. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder. All closers shall be of one (1) manufacturer. All closers shall utilize a stable fluid withstanding temperature range of 120 degrees F to –30 degrees F without seasonal adjustment of closer speed to properly close the door. Closers for fire-rated doors shall be provided with temperature stabilizing fluid that complies with standards UBC 7-2 (1997) and UL 10C.

C. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Spring power adjustment allows for quick and accurate power adjustment and visually shows closer power size settings by way of dial adjustment gauge located on closer spring tube. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed and back check. Door closers with pressure relief valves are not acceptable.
D. All closers shall have solid forged steel main arms (and forearms for parallel arm closers) and where specified shall have a cast-in solid stop on the closer shoe.

E. All surface closers shall be certified to exceed ten million full load cycles by a recognized independent testing laboratory. All closers (overhead, surface and concealed shall be of one (1) manufacturer and carry manufacturer’s ten (10) year warranty (electric closers to have two (2) year warranty).

F. Overhead concealed closers shall have spring power adjustable for 50 percent increase in closing power and fully mortised door tracks.

G. Closers to be installed to allow door swing as shown on plans. Doors swinging into exit corridors shall provide for corridor clear width as required by code. Where possible, mount closers on inside of rooms.

H. Provide brackets, mounting plates, and fastener types for closers as required for proper installation with door and frame conditions. Closers shall be attached to wood doors with sex bolts.

I. Powder coating finish to be certified to exceed 100 hours salt spray testing by ETL, an independent testing laboratory used by BHMA for ANSI certification.

J. Combination Door Closers and Holder: Provide units designed to hold door in open position under normal usage and to release and close door automatically under fire conditions. Incorporate an integral electromagnetic holder mechanism designed for use with UL listed fire detectors, provided with normally closed switching contacts.

K. Magnetic Door Holders to be heavy duty wall or floor mounted with metal housing and complete mounting hardware. Provide 24V holding coils unless otherwise scheduled.

L. Flush Floor Plates: Provide finished metal flush floor plates for floor closers except where thresholds are indicated and cover plate is specified to be an integral part of threshold. Finish floor plate to match hardware sets, unless otherwise indicated.

M. Recessed Floor Plates: Provide recessed floor plates where no thresholds are indicated and floor closers are located in an area of resilient flooring, stone flooring, or terrazzo. Recess plates to receive an insert of the floor finish material of the normal thickness as indicated. Provide extended spindle on closer as may be necessary to accommodate thickness of floor finish.

1. Where terrazzo floor finish includes metal divider or expansion strips, match exposed ring of recessed floor plate on closer with metal of floor strips.

N. Provide grey resilient parts for exposed bumpers.

O. Provide black resilient parts for exposed bumpers.

2.10 PUSH/PULL UNITS

A. Exposed Fasteners: Provide manufacturer's standard exposed fasteners for installation, through bolted for matched pairs but not for single units.

B. Concealed Fasteners: Provide manufacturer's special concealed fastener system for installation, through bolted for matched pairs but not for single units.
2.11 DOOR TRIM UNITS

A. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self tapping screws.

B. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.

C. Fabricate protection plates not more than 1-1/2 inches less than door width on hinge side and not more than 1/2 inch less than door width on pull side by height indicated.

1. Metal Plates: Stainless steel, 0.050 inch (U.S. 18-gage).
2. Metal Plates: Brass or bronze, 0.062 inch (U.S. 16-gage).
4. Plastic Plates: Plastic laminate or high impact polyethylene, 1/8 inch thick, in color selected.

2.12 WEATHERSTRIPPING AND SEALS

A. Provide continuous weatherstripping on exterior doors and smoke, light, or sound seals on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.

B. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.

C. Quality and type of materials are established herein and on the Drawings by catalogue numbers and descriptions from the catalogue of National Guard Products. Other acceptable manufacturers are: Zero International, Inc., Pemko Mfg., Co., Reese Enterprises, Inc.

2. Sweep Strip: No. 200N, mill finish.
3. Threshold: No. 425, mill finish.
4. Adjustable Head/Jamb Seals: No. 103N, mill finish.
5. Adjustable Door Bottoms: No. 222N, mill finish.
6. Threshold for Adjustable Seals: No. 950N, mill finish.
7. Rain Drip: No. 17, mill finish.
8. Top Protection: No. 16, mill finish.

2.13 HARDWARE FINISHES

A. Match items to the manufacturer's standard color and texture finish for the latch and lock sets (or push pull units if no latch or lock sets).
B. Provide finishes that match those established by ANSI/BHMA or, if none established, match the Architect's sample.

C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

D. Provide protective lacquer coating on all exposed hardware finishes of brass, bronze, and aluminum, except as otherwise indicated. The suffix "NL" is used with standard finish designations to indicate "no lacquer."

E. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.
   1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
   2. "Recommended Locations for Builders Hardware for Custom Steel Doors and Frames" by the Door and Hardware Institute.
   3. NWWDA Industry Standard I.S.1.7, "Hardware Locations for Wood Flush Doors"; applicable for flush wood doors 1-3/8 and 1-3/4 inches thick by 6 feet 8 inches and 7 feet 0 inches high.

D. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing Work specified in the Division 09 Sections. Do not install surface mounted items until finishes have been completed on the substrates involved.

E. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

G. Set thresholds for exterior doors in full bed of butyl rubber or polyisobutylene mastic sealant complying with requirements specified in Division 07 Section "Joint Sealers."
H. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

1. Where adhesive applied items are indicated, abrade or otherwise prepare the substrate for complete adhesion to ensure the items will not delaminate.

I. Install manufacturer supplied, temporary keyed construction cores for all exterior doors, suite entry doors, and doors where electrified hardware is scheduled. For all other doors, install Owner-provided, temporary non-keyed plastic construction cores unless keyed construction cores are specifically called for.

3.02 ADJUSTING, CLEANING, AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

1. Where door hardware is installed more than one (1) month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

B. Clean adjacent surfaces soiled by hardware installation.

C. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.

3.03 HARDWARE APPLICATION SCHEDULE

HINGES – Hager Hinge Co., Ives

| B 1 pr Butts BB1168 5.0 X 4.5 | USP |
| B 2 pr Butts 1279 4.5 X 4.0 | USP |
| B 3 pr Butts BB1279 4.5 X 4.0 | USP |
| B 4 pr Butts BB1168 4.5 X 4.5 | USP |
| B 5 pr Butts 1279 5.0 X 4.0 | USP |
| B 6 pr Butts BB1279 5.0 X 4.0 | USP |
| B 7 pr Butts 1279 5.0 X 4.0 | US26D |
| B 8 pr Butts 1279 4.5 x 4.0 | US26D |
| B 9 pr Butts BB1168 5.0 x 4.5 | US26D |
| B 10 pr Butts 1279 4.5 X 4.5 X NRP | USP |
| B 11 ea Continuous Hinge Rotation 780-224 HD |

DOOR CLOSERS – LCN, Norton Door Closer Company

| C 1 ea Closers P4040SW x 4040SE-3210 | 689 (24VDC less than 90M current) |
| C 2 ea Closers 4110/4111 Series | 689 |
| C 3 ea Closers 4041 Series | 689 |
| C 4 ea Closers 4010/4011 Series | 689 |
| C 5 ea Closers 4041-EDA | 689 |
| C 6 ea Closers 4040SE x 4040se-3210 | 689 (24VDC less than 90MA current) |
EXIT DEVICES – Von Duprin, Inc.

E 1 ea Exit Devices 3327 TL US 28 x Less Pull
E 2 ea Exit Devices 99L F US 28
E 3 ea Exit Devices 99L US 28
E 4 ea Exit Devices 3327 EO US 28

For functions other than listed above suffix the following:
  a. NL Key retracts latchbolt
  b. LBR Less bottom rod
  c. ALK Exit Alarm Kit

For electronic functions prefix the following:
  a. CX Delay egress
  b. EL Electronic latch retraction
  c. E Electronic locking or unlocking of trim
  d. RX Request to exit feature
  e. LX Monitors exit device latch bolt
  f. SS Indicates unauthorized use of opening

FLOOR CLOSERS – Rixson, Inc.

FC 1 sets D.A. Floor Closers 30 US26D

CYLINDERS – Best Access Systems

CL 1 ea Mortise Cylinders 1E 74 US10B x Required Cam
CL 2 ea Rim Cylinders 1E 72 US26D
CL 3 ea Mortise Cylinders 1E 74 US26D x Required Cam

MORTISED LOCKSETS, DEAD LOCKS, LATCHSETS – Best Access Systems (14H trim design) NO SUBSTITUTION

Provide all locksets in RM (Rosemont) trim design instead of MF.
LM – 4 ea Mortise Locksets 35H-7E-14H 626
LM – 5 ea Mortise Storeroom Locksets 35H-7EW-14H 626 x Outside Lever Knurled
LM – 6 ea Mortise Storeroom Locksets 35H-7EW-14H 626
LM – 7 ea Mortise Dbl Cylinder Office Locksets 35H-7G-14H 626
LM – 8 ea Mortise Classroom Locksets 35H-7J-14H 626
LM – 9 ea Mortise Privacy Locksets 35H-LF-14H 626
LM – 10 ea Mortise Dead Locks 35H-7T 626
LM – 11 ea Mortise Latchsets 35H-N-14H 626
LM – 12 ea Mortise Privacy Locksets 35H-LF-14H 626 X 2 Thumb Turns
LM – 13 ea Mortise Entrance Locksets 35H-7AW-14H 626
LM – 14 ea Mortise Communicating Locksets 35H-7C-14H 626
LM – 15 ea Ives Roller Latches RL30 US26D
LP – 1 ea Programmable Mortise Lock 35HZ7EV14KP 626
LP – 2 ea Programmable Mortise Lock 35HZ7FV14KP 626
### CYLINDRICAL LOCKSETS, DEAD LOCKS, LATCHES – Best Access Systems (14C trim design) NO SUBSTITUTION

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Cylindrical Entrance Locksets 93K-7AB-14C</td>
<td>626</td>
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<tr>
<td>5</td>
<td>Cylindrical Storeroom Locksets 93K-7D-14C</td>
<td>626</td>
</tr>
<tr>
<td>6</td>
<td>Cylindrical Storeroom Locksets 93K – 7D-14C</td>
<td>626</td>
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<tr>
<td>7</td>
<td>Cylindrical Corridor Locksets 93K-7C-14C</td>
<td>626</td>
</tr>
<tr>
<td>8</td>
<td>Cylindrical Classroom Locksets 93K-7R-14C</td>
<td>626</td>
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<td>9</td>
<td>Cylindrical Privacy Locksets 93KOL-14C</td>
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<td>10</td>
<td>Mortise Dead Locks 34H-7T</td>
<td>626</td>
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<td>11</td>
<td>Cylindrical Latchsets 93K-N-14C</td>
<td>626</td>
</tr>
<tr>
<td>12</td>
<td>Cylindrical Privacy Locksets with 2 Thumb Turns (Not available)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Cylindrical Lockset with Dead Bolt (Not available)</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Cylindrical Communicating Locksets 93K-7S-14C</td>
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<td>15</td>
<td>Ives Roller Latches RL30</td>
<td>US26D</td>
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<tr>
<td>3</td>
<td>Programmable Cylindrical Lock 93KZ7DV14KP-S3</td>
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### PULLS, PUSH PLATES, ARMOR PLATES, KICK PLATS & END CAPS – Ives, Rockwood, Trimco Hardware

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<td>1</td>
<td>Pulls Ives 8103EZ-0</td>
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<td>2</td>
<td>Push Plates Ives 8200 – 6&quot; X 16&quot;</td>
<td>US32D</td>
</tr>
<tr>
<td>3</td>
<td>Ives Pull Plate 8303EZ-0 – 6&quot; X 16&quot; US 32D</td>
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<td>4</td>
<td>Offset Pulls Ives 8190-0</td>
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<td>Armor Plates Ives 8400. 36&quot; x 1&quot; L.W.D. x 0.50</td>
<td>US32D</td>
</tr>
<tr>
<td>2</td>
<td>Armor Plates Ives 8400. 54&quot; X 1 ½&quot; L.W.D. x 0.50</td>
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<td>Armor Plates Ives 8400. 50&quot; X 1 ¼&quot; L.W.D. x 0.50</td>
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<td>4</td>
<td>Armor Plates Ives 8400. 52&quot; X 1&quot; L.W.D. x 0.50</td>
<td>US32D</td>
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<tr>
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<td>Kick Plates Ives 8400. 10&quot; x 1 ½&quot; L.W.D. x 0.50</td>
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</tr>
<tr>
<td>1</td>
<td>Edge Guards Rockwood 306</td>
<td>US32D Full Height of Door</td>
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### SILENCERS, STOPS, HOLDERS, FLUSH BOLTS, DUST PROOF STRIKES, PUSH/PULL LATCHES & COORDINATORS – Ives, Rockwood, Trimco Hardware

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<tr>
<td>1</td>
<td>Silencers Ives SR 64</td>
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<td>2</td>
<td>Wall Stops Ives WS407CCV</td>
<td>US32D</td>
</tr>
<tr>
<td>3</td>
<td>Floor Stops Ives FS13/R14</td>
<td>US26D</td>
</tr>
<tr>
<td>4</td>
<td>Floor Holders Ives FS40</td>
<td>US26D</td>
</tr>
<tr>
<td>5</td>
<td>Flush Bolts Ives FB458-12&quot;</td>
<td>US26D</td>
</tr>
<tr>
<td>6</td>
<td>Dust Proof Strikes Ives DP 2</td>
<td>US26D</td>
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<td>7</td>
<td>Wall Stops Ives WS11X</td>
<td>US26D</td>
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<td>8</td>
<td>Push/Pull Latches GJ HL 6</td>
<td>US32D x 5” B.S.</td>
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<td>9</td>
<td>Overhead Friction Holders GJ 410 Series</td>
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<tr>
<td>10</td>
<td>Overhead Holders GJ 90H Series</td>
<td>US32D</td>
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<tr>
<td>11</td>
<td>Automatic Flush Bolts Ives FB30 or FB40 x US32D</td>
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<td>12</td>
<td>Coordinators Ives COR Series US P x Filler Bar</td>
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### MISCELLANEOUS

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<td>2</td>
<td>Ives Center Hung Pivots 7255</td>
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<tr>
<td>3</td>
<td>Hagar Emg. Stop &amp; Release 455/456</td>
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3.04 HARDWARE SETS

### HARDWARE GROUP NO.01

Each To Have:

<table>
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<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
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<th>Mfr</th>
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<td>HINGE 5BB1HW 5 X 4.5 NRP</td>
<td>5BB1HW</td>
<td>652</td>
<td>IVE</td>
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<tr>
<td>1</td>
<td>POWER TRANSFER EPT10</td>
<td>EPT10</td>
<td>689</td>
<td>VON</td>
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<td>ELEC FIRE EXIT QEL-98-L- BE-F X MATCH EXISTING LEVER HARDWARE</td>
<td>QEL-98-L- BE-F</td>
<td>626</td>
<td>VON</td>
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<tr>
<td>1</td>
<td>RIM CYLINDER 1E72 X MATCH EXISTING KEYING</td>
<td>1E72 X MATCH EXISTING KEYING</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>SURF. AUTO 9542 MS</td>
<td>9542 MS</td>
<td>626</td>
<td>BES</td>
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<td>2</td>
<td>ACTUATOR, WALL MOUNT 8310-853T</td>
<td>8310-853T</td>
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<td>ARMOR PLATE 8400 36&quot; X 2&quot; LDW B-CS</td>
<td>8400 36&quot; X 2&quot;</td>
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<td>IVE</td>
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<tr>
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<td>WALL STOP WS407CCV</td>
<td>WS407CCV</td>
<td>630</td>
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<td>GASKETING 188FSBK PSA</td>
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<td>BK</td>
<td>ZER</td>
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**POWER SUPPLY - WORK OF DIVISION 28 @ QEL**

**OPERATIONAL DESCRIPTION:** FREE ENTRY AT ALL TIMES. PRESSING EITHER ACTUATOR TO INITIATE ELECTRIC LATCH RETRACTION AND AUTO OPERATOR. FREE EGRESS AT ALL TIMES.
SECTION 09 22 16 – NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.03 QUALITY ASSURANCE

A. Fire Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies whose fire resistance rating has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.

1. Provide fire resistance rated assemblies identical to those indicated by reference to GA File No's. in GA 600 "Fire Resistance Design Manual" or to design designations in U.L. "Fire Resistance Directory" or in listing of other testing agencies acceptable to authorities having jurisdiction.

1.04 SUBMITTALS

A. Product Data:

1. Submit product data consisting of manufacturer's product Specifications and installation instructions for each product, including data showing compliance with the requirements.

B. Record Documents:

1. Provide record approved product data.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
2.02 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include:

1. Dale/Incor Inc.
2. Dietrich Industries Inc.
3. Marino/Ware
4. Unimast Inc.
5. USG Corp.

2.03 STEEL FRAMING FOR WALLS AND PARTITIONS

A. Design Criteria: Design metal stud partitions to have deflection not to exceed l/240 under a 5 psf lateral load. Where height of stud required exceeds the deflection criteria shown in manufacturer’s printed engineering charts, provide heavier gauge studs, or closer spacing, as required for actual span conditions.

B. Steel Studs and Runners: ASTM C 645, with flange edges of studs bent back 90 degrees and doubled over to form 3/16 inch minimum lip (return) and complying with the following requirements for minimum thickness and depth:

1. Thickness: 0.0270 inch (22 gauge, or structurally equivalent), unless otherwise indicated.
2. Thickness: 0.0179 inch (25 gauge, or structurally equivalent) where indicated.
3. Thickness: 0.0329 inch (20 gauge, or structurally equivalent) where indicated.
4. Depth: 3-5/8 inches, unless otherwise indicated.
5. Depth: 6 inches where indicated.
6. Depth: 4 inches where indicated.
7. Depth: 2-1/2 inches where indicated.
9. Depth: As indicated.

C. Steel Rigid Furring Channels: ASTM C 645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:

1. Depth: 7/8 inch.
2. Depth: 1-1/2 inch.
3. Thickness: 0.0329 inch (20 gauge), unless otherwise indicated.
D. Furring Brackets: Serrated arm type, adjustable, fabricated from corrosion resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.

E. Steel Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission, complying with ASTM C 645 for base metal, finish and widths of face and fastening flange, fabricated to form 1/2 inch deep channel of the following configuration:

1. Single Leg Configuration: Assymetric shaped channel with face connected to a single flange by a single slotted leg (web).

2. Double Leg Configuration: Hat shaped channel, with 1-1/2 inch wide face connected to flanges by double slotted or expanded metal legs (webs).

3. Configuration: Either one indicated above.

F. Z Furring Members: Manufacturer's standard zee shaped furring members with slotted or nonslotted web, fabricated from hot dip galvanized steel sheet complying with ASTM A 525, Coating Designation G60; with a minimum base metal (uncoated) thickness of 0.0179 inch, face flange of 1-1/4 inch, wall attachment flange of 7/8 inch, and of depth required to fit insulation thickness indicated.

G. Fasteners: Provide fasteners of type, material, size, corrosion resistance, holding power and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum drywall manufacturers for applications indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.02 INSTALLATION OF STEEL FRAMING, GENERAL

A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.

1. Steel Stud Systems to Receive Metal Lath: Comply with requirements of ML/SFA 920, "Guide" "Specifications for Metal Lathing and Furring" applicable to each installation condition and type of metal stud system indicated.

B. Install supplementary framing, blocking and bracing at terminations in the Work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar construction to comply with details indicated and with recommendations of gypsum board manufacturer, or if none available, with "Gypsum Construction Handbook" published by United States Gypsum Co.
C. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement, at locations indicated below to comply with details shown on Drawings:

1. Where edges of suspended ceilings abut building structure horizontally at ceiling perimeters or penetration of structural elements.

2. Where partition and wall framing abuts overhead structure.
   a. Provide slip or cushioned type joints as detailed to attain lateral support, avoid axial loading, and maintain structural performance of partition.
   b. At non-load bearing partitions constructed to underside of floor or roof deck, provide for ½ inch of deflection at studs. Attach studs to slotted track, or hold studs down from top of deep leg track and do not attach to track.
   c. Provide UL-listed components for use in fire resistance rated head of partition joint systems indicated.

D. Do not bridge building expansion and control joints with steel framing or furring members; independently frame both sides of joints with framing or furring members or as indicated.

3.03 INSTALLATION OF STEEL FRAMING FOR WALLS AND PARTITIONS

A. Install runners (tracks) at floors, ceilings and structural walls and columns where gypsum drywall stud system abuts other construction.

1. Where studs are installed directly against exterior walls, install asphalt felt strips between studs and wall.

B. Installation Tolerances: Install each steel framing and furring member so that fastening surface does not vary more than 1/8 inch from plane of faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

D. Terminate partition framing at suspended ceilings where indicated.

E. Install steel studs and furring in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.

1. For single layer construction: Unless otherwise indicated, 16 inches on center.

F. Install steel studs so that flanges point in the same direction and gypsum boards can be installed in the direction opposite to that of the flange.

G. Frame door openings to comply with details indicated, with GA 219 and with applicable published recommendations of gypsum board manufacturer. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Extend vertical jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
H. Frame openings other than door openings to comply with details indicated, or if none indicated, in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads.

END OF SECTION 09 22 16
SECTION 09 29 00 - GYPSUM DRYWALL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.03 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA 505 for definitions of terms for gypsum board construction not otherwise defined in this section or other referenced standards.

1.04 QUALITY ASSURANCE

A. Fire Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies whose fire resistance rating has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.

1. Provide fire resistance rated assemblies identical to those indicated by reference to GA File No's. in GA 600 "Fire Resistance Design Manual" or to design designations in U.L. "Fire Resistance Directory" or in listing of other testing agencies acceptable to authorities having jurisdiction.

B. Perform gypsum board Work in accordance with recommendations of ASTM C 754 and GA 216 unless otherwise indicated or required by project conditions.

C. Keep a copy of GA 216 and GA 600 in field office for duration of project.

D. Single Source Responsibility: Obtain each type of gypsum board and related joint treatment materials from a single manufacturer.

1.05 SUBMITTALS

A. Product Data:
1. Submit manufacturer’s technical literature for each product and system indicated.

2. Submit copies of each UL design selected for each required fire resistance rating for gypsum drywall assemblies including installer certification that each UL design selected will provide the scheduled fire resistance rating in accordance with local Codes.

3. Submit certification and test results that clearly state and indicate that each individual element and component of fire rated gypsum drywall assemblies are approved and appropriately rated for specific rated assembly for which it is to be used, and that the use of such individual element will in no way jeopardize the required rating of the assembly.

B. Shop Drawings:

1. Show details of fabrication and installation, including plans, elevations, sections, details of components and attachments to other work. Include scaled and dimensioned drawings showing control and expansion joints in walls and ceilings.

C. Record Documents:

1. Provide record approved product data and shop drawings.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging.

C. Handle gypsum boards to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.07 SEQUENCING AND SCHEDULING

A. Sequence installation of gypsum sheathing board with installation of exterior cladding to comply with requirements indicated below:

1. Do not leave gypsum sheathing board exposed to the weather after application for longer than one month.

2. Do not leave gypsum sheathing board exposed to weather after its application for more than one month or, if protected as indicated below, for more than 6 months:

   a. Protect cutouts, corners and joints in the sheathing by filling them with a flexible sealant at the time sheathing is applied.

   b. As an alternate to sealant application, cover exposed exterior surface of sheathing with building paper or air infiltration barrier. Anchor covering with metal lath securely fastened through sheathing to framing. Apply covering immediately after sheathing is installed.
1.08 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for application and finishing gypsum board to comply with ASTM C 840 and with gypsum board manufacturer's recommendations.

B. Minimum Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40 degrees F (4 degrees C). For adhesive attachment and finishing of gypsum board maintain not less than 50 degrees F (10 degrees C) for 48 hours prior to application and continuously thereafter until drying is complete.

C. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials from drying too rapidly.

1.09 ASSEMBLY PERFORMANCE REQUIREMENTS

A. Sound Transmission Characteristics: For gypsum board assemblies indicated to have STC ratings, provide materials and construction identical to those of assemblies whose STC ratings were determined per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing agency.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include the following:

1. Grid Suspension Systems:
   a. Armstrong World Industries.
   b. Chicago Metallic Corp.
   c. USG Corporation.

2. Gypsum Board and Related Products:
   a. Georgia Pacific Corp.
   c. Temple-Inland.
   d. USG Corporation.
2.03 STEEL FRAMING COMPONENTS FOR SUSPENDED AND FURRED CEILINGS

A. General: Provide components which comply with ASTM C 754 for materials and sizes, unless otherwise indicated.

B. Concrete Inserts: Inserts designed for attachment to concrete forms and for embedment in concrete, fabricated from corrosion resistant materials, with holes or loops for attachment of hanger wires and capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined from testing per ASTM E 488, conducted by an independent testing laboratory.

C. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.

D. Hanger Rods: Mild steel, zinc coated or protected with rust inhibitive paint.

E. Flat Hangers: Mild steel, zinc coated or protected with rust inhibitive paint.

F. Angle Type Hangers: Angles with legs not less than 7/8 inch wide, formed from 0.0635 inch thick galvanized steel sheet complying with ASTM A 653/A 653M, Coating Designation G90, with bolted connections and 5/16 inch diameter bolts.

G. Channels: Cold rolled steel, 0.0598 inch minimum thickness of base (uncoated) metal and 7/16 inch wide flanges, protected with rust inhibitive paint, and as follows:
   1. Carrying Channels: 2 inches deep, 590 lbs per 1000 feet, unless otherwise indicated.
   2. Carrying Channels: 1-1/2 inch deep, 475 lbs per 1000 feet, unless otherwise indicated.
   3. Furring Channels: 3/4 inch deep, 300 lbs per 1000 feet, unless otherwise indicated.

H. Grid Suspension System: ASTM C 645, manufacturer's standard grid suspension system composed of main beams and cross furring members which interlock to form a modular supporting network.
   1. Non Fire Rated Direct Hung Suspended Drywall Furring System: Heavy-duty, double web steel main and cross runners with 1-3/8 inch wide capped flange face for screw attachment, and channel type wall track at perimeter; Chicago Metallic "640 Furring System".

2.04 GYPSUM BOARD

A. Provide gypsum board of types indicated in maximum lengths available to minimize end to end joints.
   1. Provide gypsum board in thicknesses indicated, or if not otherwise indicated, in 5/8 inch thicknesses to comply with ASTM C 840 for application system and support spacing indicated.

B. Gypsum Wallboard: ASTM C 1396/C 1396M, "Regular" for vertical surfaces, "Sag-Resistant for ceilings, and as follows:
   1. Type: Type X where required for fire-resistant rated assemblies.
   2. Type: Foil backed where indicated.

4. Thickness: 5/8 inch, unless otherwise indicated.

5. Subject to compliance with requirements, products which may be incorporated in the Work where "Regular" gypsum wallboard is indicated include:
   a. "GP Gypsum Board"; Georgia Pacific Corp.
   c. "SHEETROCK Brand Gypsum Panels"; USG Corporation.

6. Subject to compliance with requirements, products which may be incorporated in the Work where "Type X" gypsum wallboard is indicated include:
   a. "Firestop Type C"; Georgia Pacific Corp.
   c. "SHEETROCK Brand FIRECODE 'C' Gypsum Panels"; USG Corporation.

C. Gypsum Backing Board for Multi-Layer Applications: ASTM C 1396/C 1396M, and as follows:
   1. Type: Type X for fire resistance rated assemblies.
   2. Edges: Manufacturer's standard.

D. Water Resistant Gypsum Backing Board: ASTM C 1396/C 1396M, and as follows:
   1. Type: Regular, unless otherwise indicated.
   2. Type: Type X for fire resistance rated assemblies.
   3. Thickness: 5/8 inch, unless otherwise indicated.

E. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer's standard edges, of type and thickness indicated below:
   1. Type: Regular, unless otherwise indicated.
   2. Type: Type X for fire resistance rated assemblies.
   3. Thickness: 5/8 inch, unless otherwise indicated.

2.05 SHAFT-WALL SYSTEM DESCRIPTION

A. Performance Requirements, General: Provide gypsum board shaft wall systems complying with performance requirements specified, as demonstrated by pretesting manufacturer's corresponding stock systems.

B. Fire Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies, including those incorporating elevator door and other framing, whose fire resistance has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.
1. Provide fire resistance rated assemblies identical to those indicated by reference to GA File No.'s in GA 600 "Fire Resistance Design Manual" or to design designations in UL "Fire Resistance Directory" or in listings of other testing and inspecting agencies acceptable to authorities having jurisdiction.

C. Steel Framing: ASTM C 645, of profile, size, and base metal thickness required to produce assemblies complying with structural performance requirements, with sectional properties computed to conform with AISI "Specification for Design of Cold Formed Steel Structural Members."

D. Gypsum Shaftwall Board: ASTM C 1396/C 1396M, Type X liner panel or coreboard designed for shaft wall construction, with moisture resistant paper facings.

E. Structural Performance Characteristics: Provide gypsum board shaft wall systems engineered to withstand the following lateral design loadings (air pressures), applied transiently and cyclically, for maximum heights of partitions required, within the following deflection limits, verified by pretesting for deflection characteristics:
   1. Lateral Loading: As indicated but not less than 10 psf.

F. Sound Attenuation Performance: Provide gypsum board shaft wall systems designed and pretested to achieve the following minimum ratings for sound transmission class (STC) per ASTM E 90.
   1. STC Rating: As indicated but not less than 35.

G. Cavity Shaft Wall Systems: Provide assemblies consisting of gypsum shaft wall boards inserted between U or J shaped metal floor and ceiling tracks; with specially shaped studs engaged in tracks and fitted between shaftwall boards; and gypsum boards on finished side or sides applied to studs in number of layers, thicknesses and arrangement indicated.
   1. Shaftwall Board Thickness: As indicated.
   2. Stud Shape: I, C H or double E.
   3. Stud Thickness: 0.0179 inch min. thickness of base metal unless otherwise indicated or required.
   4. Stud Depth: As indicated.
   5. Room Side Finish: As indicated.
   6. Shaft Side Finish: One layer of gypsum board; provide only where finish is indicated on shaft side as well as room side, otherwise leave exposed.

2.06 GYPSUM SHEATHING AT EIFS SYSTEMS

A. Glass Mat Gypsum Board: Gypsum board designed as an exterior substrate for a weather barrier, consisting of a noncombustible water resistant core, essentially gypsum, surfaced with glass mats on face and back, partially or completely embedded in core, and with unsurfaced square edges. Comply with ASTM C 1177 and requirements indicated below:
1. Type: Regular unless Type X is required by Project conditions.
2. Thickness: 1/2 inch unless otherwise indicated.
3. Size: 4 feet by 8 feet.

B. Product: Dens Glass Gold Exterior Sheathing, Georgia Pacific Corp.

2.07 GYPSUM SHEATHING AT ALL OTHER LOCATIONS

A. Gypsum Sheathing Board with Water Resistant Core: Gypsum sheathing board consisting of noncombustible gypsum core incorporating a water resistant material, surfaced on face, back and long edges with water repellent paper; complying with ASTM C 1396/C 1396M and requirements indicated below:

1. Type: Regular (not Type X).
2. Edge and End Configuration: V shaped tongue and groove long edges, square ends.
3. Thickness: 1/2 inch.
4. Size: 2 feet by 8 feet.

B. Subject to compliance with requirements, gypsum sheathing boards which may be incorporated in the Work include, but are not limited to, the following:

3. USG Gypsum Sheathing; USG Corporation.

C. Sheathing Tape: Tape specifically designed and manufactured to seal joints in gypsum sheathing against water and air infiltration, formulated with an adhesive that permanently bonds to gypsum sheathing substrates, and as indicated below:

1. Polyethylene backed SBS modified sheathing joint tape, 0.0020 inch thick membrane, 4 inch wide: Protecto Flash Building Tape by Protecto Wrap Company, Denver, Colorado.
2. Linterless polypropylene sheathing tape, 0.0027 inch thick, 2-1/2 inches wide, composed of oriented polypropylene backing coated with permanent acrylic adhesive formulated to adhere to gypsum sheathing surfaces: No. 8086 Contractor Sheathing Tape, 3M Contractor Products.
3. Polyethylene tape, 0.025 inch thick, 3 inches wide, composed of polyethylene backing coated with synthetic rubber based adhesive: POLYKEN 612 Seam Seal Tape, Polyken Technologies.

2.08 TRIM ACCESSORIES

A. Cornerbead and Edge Trim for Interior Installation: Provide corner beads, edge trim and control joints which comply with ASTM C 1047 and requirements indicated below:
1. Material: Formed metal, plastic or metal combined with paper, with metal complying with the following requirement:
   a. Sheet steel zinc coated by hot dip process.
   b. Sheet steel coated with zinc by hot dip or electrolytic processes, or with aluminum.

2. One Piece Control Joint: Formed with vee shaped slot per Fig. 1 in ASTM C 1047, with slot opening covered with removable strip.

B. Aluminum Edge Trim: Where indicated, provide manufacturer's standard extruded aluminum edge trim of profile shown or referenced by manufacturer's standard product designation, fabricated from aluminum alloy 6063 T5 complying with ASTM B 221, with clear anodized finish.

1. Manufacturer: Subject to compliance with requirements, provide aluminum accessories of one of the following:
   a. Fry Reglet Corp.
   b. Gordon, Inc.
   c. MM Systems, Corp.

C. Metal Cornerbead and Edge Trim for Exterior Ceilings: Comply with ASTM C 1047, formed from rolled zinc.

2.09 SHEATHING ACCESSORY MATERIALS

A. Air Infiltration Barrier: As follows:

1. Asphalt saturated organic felt complying with ASTM D 226, Type I (No. 15 asphalt felt), unperforated.

2. Plastic Sheet as indicated below:

   a. Polyethylene sheet formed by spinning continuous strands of fine high density polyethylene interconnected fibers and bonding them together by heat and pressure; and as follows:

      1) Thickness: 0.0061 inch thick.
      2) Basic Weight: 8.81 lb per 1000 sq. ft. per ASTM D 646.
      3) Roll Widths and Lengths: 3 feet by 165 feet, 9 feet by 195 feet.
      4) Moisture Vapor Transmission Rate: 795.38 grams/sq. meter/24 hours per ASTM E 96, Procedure A.
      5) Surface Burning Characteristics: Flame spread: 5; smoke developed: 10; per ASTM E 84.
      6) Product: Subject to compliance with requirements, provide “Tyvek Housewrap” by Textile Fibers Department, Du Pont Company.
B. Fasteners: Type S steel drill screws, 1 inch long, with corrosion resistant finish in form of cadmium plating or proprietary coating, and as follows:

1. For attachment of sheathing to light gage steel framing of less than 0.033 of an inch in thickness, provide steel drill screws complying with ASTM C 1002.

2. For attachment of sheathing to steel framing from 0.033 to 0.112 of an inch in thickness, provide steel drill screws complying with ASTM C 954.

C. Sealant: Solvent release curing joint sealant compatible with joint substrates formed by gypsum sheathing and other related materials and complying with requirements of Division 07 Section "Joint Sealants."

2.10 GYPSUM BOARD JOINT TREATMENT MATERIALS

A. Provide materials complying with ASTM C 475, ASTM C 840, and recommendations of manufacturer of both gypsum board and joint treatment materials for the application indicated.

2.11 MISCELLANEOUS MATERIALS

A. Provide auxiliary materials for gypsum drywall construction which comply with referenced standards and the recommendations of the manufacturer of the gypsum board.

B. Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum boards.

C. Spot Grout: ASTM C 475, setting type joint compound of type recommended for spot grouting hollow metal door frames.


E. Fastening Adhesive for Metal: Special adhesive recommended for laminating gypsum boards to steel framing.

F. Gypsum Board Screws: ASTM C 1002.

G. Gypsum Board Nails: ASTM C 514.

H. Asphalt Felt: ASTM D 226, Type I (No. 15).

I. Concealed Acoustical Sealant: Nondrying, nonhardening, nonskinning, nonstaining, nonbleeding, gunnable sealant complying with requirement specified in Division 07 Section "Joint Sealants."

J. Sound Attenuation Blankets: Unfaced mineral fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing); and as follows:

1. Mineral Fiber Type: Fibers manufactured from glass or slag.
   a. Owens Corning Fiberglas "Firecore 60 Sound Attenuation Batts".
   b. USG Corporation "Thermafiber Sound Attenuation Fire Blankets".
2. Provide blankets in thicknesses shown or, if not shown, in manufacturer's standard nominal thickness corresponding to the wall stud width.

K. Sound Pads: Flat sheets of heavy, mastic, flexible, non-hardening material such as "Sound Pad #68" manufactured by L. H. Dottie Company.

L. Security Mesh: ¾ inch x 16 gage, flatten.

M. Vapor Retarder: Two outer layers of polyethylene film and one inner layer of nylon reinforcing, with an overall thickness of 6.0 to 8.0 mils.

N. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either a nonwoven grid of nylon cord or polyester scrim and weighing not less than 26 lb/1000 sq. ft. (13 kg/100 sq.m), with maximum permeance rating of 0.0403 perm (2.3 ng/PA x s x sq. m) and flame-spread and smoke-developed values of not more than 5 and 75, respectively.

1. Subject to compliance with requirements, products that may be incorporated in the Work include:


O. Tape for Vapor Retarder: Pressure sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.12 TEXTURE FINISH MATERIALS

A. Primer: Of type recommended by manufacturer of texture finish.

B. Polystyrene Aggregated Finish for Ceilings: Manufacturer's standard proprietary product formulated with polystyrene aggregates for spray application, with surface burning characteristics of 25 per ASTM E 84, and in texture indicated.

C. Products: Subject to compliance with requirements, provide one of the following products:

1. "IMPERIAL QT SPRAY Medium Texture Finish"; USG Corporation.

2. "IMPERIAL QT SPRAY Coarse Texture Finish"; USG Corporation.


PART 3 - EXECUTION

3.01 PREPARATION

A. Examine substrates to which drywall construction attaches or abuts, preset hollow metal frames, cast-in anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of drywall construction. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Ceiling Anchorages: Coordinate installation of ceiling suspension system with installation of overhead structural systems to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling anchors in a manner that will develop their full strength and at spacing required to support ceiling.

1. Furnish concrete inserts and other devices indicated, to other trades for installation well in advance of time needed for coordination with other construction.

C. Before sprayed on fireproofing is applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed on fireproofing. Where offset anchor plates are required provide continuous units fastened to building structure not more than 24 inches on center and to ceiling runners.

D. After sprayed on fireproofing has been applied, remove only as much fireproofing as needed to complete installation of drywall construction. Protect fireproofing that remains from damage.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.03 INSTALLATION OF STEEL FRAMING FOR SUSPENDED CEILINGS

A. Install suspended steel framing components in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.

B. Suspend ceiling hangers from building structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

4. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

5. Do not support ceilings directly from permanent metal forms. Furnish cast in place hanger inserts that extend through forms.

6. Do not attach hangers to steel deck tabs.

7. Do not attach hangers to steel roof deck. Attach hangers to structural members.

8. Do not connect or suspend steel framing from ducts, pipes or conduit.

C. Sway brace suspended steel framing with hangers used for support.

D. Installation Tolerances: Install steel framing components for suspended ceilings so that cross furring members or grid suspension members are level to within 1/8 inch in 12 feet as measured both lengthwise on each member and transversely between parallel members.

E. Wire tie or clip furring members to main runners and to other structural supports as indicated.

F. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross furring members to each other and butt cut to fit into wall track.

3.04 APPLICATION AND FINISHING OF GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standard: Install and finish gypsum board to comply with ASTM C 840 and GA 216.

B. Install polyethylene vapor retarder on framing members of exterior insulated walls to comply with the following requirements:

1. Extend vapor retarder to extremities of exterior insulated walls and to cover miscellaneous voids in insulated substrates, including those which have been stuffed with loose thermal insulation.

2. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 16 inches on center.

3. Seal joints in vapor retarder caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with cloth or aluminized tape which bonds permanently to vapor retarder.

4. Repair tears or punctures in vapor retarder immediately before concealment by application of gypsum board or other construction.
C. Install sound attenuation blankets where indicated, prior to gypsum board unless readily installed after board has been installed.

1. Install sound pad sheets on the back of any device or accessory that is mounted in a drywall partition shown on Drawings to have an STC rating. Devices and accessories include: electrical receptacles, electrical outlet boxes, toilet accessories, and medical gas outlets.

D. Locate exposed end butt joints as far from center of walls and ceilings as possible, and stagger not less than 24 inches in alternate courses of board.

E. Install ceiling boards across framing in the manner which minimizes the number of end butt joints, and which avoids end joints in the central area of each ceiling. Stagger end joints at least 24 inches.

F. Install wall/partition boards in manner which minimizes the number of end butt joints or avoids them entirely where possible. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs.

G. Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16 inch open space between boards. Do not force into place.

H. Locate either edge or end joints over supports, except in horizontal applications where intermediate supports or gypsum board back blocking is provided behind end joints. Position boards so that like edges abut, tapered edges against tapered edges and mill cut or field cut ends against mill cut or field cut ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.

I. Attach gypsum board to steel studs so that leading edge or end of each board is attached to open (unsupported) edge of stud flange first.

J. Attach gypsum board to supplementary framing and blocking provided for additional support at openings and cutouts.

K. Spot grout hollow metal door frames for solid core wood doors, hollow metal doors and doors over 32 inches wide. Apply spot grout at each jamb anchor clip just before inserting board into frame.

L. Form control joints and expansion joints at locations indicated, with space between edges of boards, prepared to receive trim accessories.

M. Cover both faces of steel stud partition framing with gypsum board in concealed spaces (above ceilings, etc.), except in chase walls which are braced internally.

1. Except where concealed application is indicated or required for sound, fire, air or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. area, and may be limited to not less than 75 percent of full coverage.

2. Fit gypsum board around ducts, pipes, and conduits.

3. Where partitions intersect open concrete coffers, cut gypsum board to fit profile of coffers and allow 1/4 to 1/2 inch wide joint for sealant.
N. Isolate perimeter of non-load bearing drywall partitions at structural abutments. Provide 1/4 inch to 1/2 inch space and trim edge with "U" bead edge trim. Seal joints with acoustical sealant.

O. Where sound rated drywall construction is indicated, seal construction at perimeters, control and expansion joints, openings and penetrations (including all conduits, pipes, etc) with a continuous bead of acoustical sealant including a bead at both faces of partitions. Comply with ASTM C 919 and manufacturer's recommendations for location of edge trim, and close off sound flanking paths around or through construction, including sealing of partitions above acoustical ceilings.

1. For double layer partition systems, construction above acoustical ceilings may be installed with base layer only.

P. At all non-rated smoke partitions and barriers, seal penetrations (including all conduits, pipes, etc) and holes.

Q. Seal penetrations and holes in Rated smoke walls to comply with requirements specified in Division 08 Section "Penetration Firestopping".

R. Space fasteners in gypsum boards in accordance with referenced gypsum board application and finishing standard and manufacturer's recommendations.

3.05 METHODS OF GYPSUM BOARD APPLICATION

A. Single Layer Application: Install gypsum wallboard as follows:

1. On ceilings apply gypsum board prior to wall/partition board application to the greatest extent possible.

2. On partitions/walls apply gypsum board vertically (parallel to framing), unless otherwise indicated, and provide sheet lengths which will minimize end joints.

3. On Z furring members apply gypsum board vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Wall Tile Base: Where drywall is base for thin set ceramic tile and similar rigid applied wall finishes, install gypsum backing board.

1. In "dry" areas install gypsum backing board or wallboard with tapered edges taped and finished to produce a flat surface.

C. At showers, tubs and similar "wet areas" install glass mesh mortar units and treat joints to comply with ANSI A108.11 and manufacturer's recommendations for type of application indicated.

D. Double Layer Application: Install gypsum backing board for base layer and gypsum wallboard for face layer.

1. On ceilings apply base layer prior to application of base layer on walls/partitions; apply face layers in same sequence. Offset joints between layers at least 10 inches. Apply base layers at right angles to supports unless otherwise indicated.
2. On partitions/walls apply base layer and face layers vertically (parallel to framing) with joints of base layer over supports and face layer joints offset at least 10 inches with base layer joints.

3. On Z furring members apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

E. Acoustical Tile Base: Where drywall is base for adhesively applied acoustical tile, install gypsum backing board.

   1. Provide either V joint type backing board or tape and finish joints to produce a flat surface.

F. Single Layer Fastening Methods: Apply gypsum boards to supports as follows:

   1. Fasten with screws.
   2. Fasten to steel framing with adhesive and supplementary screws.
   3. Fasten to wood supports with single nailing.
   4. Fasten to wood supports with double nailing.
   5. Fasten to wood supports with adhesive and supplementary nails or screws.

G. Double Layer Fastening Methods: Apply base layer of gypsum board and face layer to base layer as follows:

   1. Fasten base layers with screws and face layer with adhesive and supplementary fasteners.
   2. Fasten base layers to wood supports with nails and face layer with adhesive and supplementary fasteners.

H. Direct Bonding to Substrate: Where gypsum board is indicated to be directly adhered to a substrate (other than studs, joists, furring members or base layer of gypsum board), comply with gypsum board manufacturer's recommendations, and temporarily brace or fasten gypsum board until fastening adhesive has set.

I. Exterior Soffits and Ceilings: Apply exterior gypsum soffit board perpendicular to supports, with end joints staggered over supports. Install with 1/4 inch open space where boards abut other construction.

   1. Fasten with cadmium plated screws, or with galvanized or aluminum nails where supports are nailable.

3.06 INSTALLATION OF DRYWALL TRIM ACCESSORIES

A. General: Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges to comply with manufacturer's recommendations.

B. Install corner beads at external corners.
C. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi exposed, and except where plastic trim is indicated. Provide type with face flange to receive joint compound except where "U" bead (semi finishing type) is indicated.

D. Install U bead where indicated, and where exterior gypsum board edges are not covered by applied moldings or indicated to receive edge trim with face flanges covered with joint compound.

E. Install plastic edge trim where indicated on wall panels at juncture with ceilings.

F. Install control joints at locations indicated, or if not indicated, at spacings and locations required by referenced gypsum board application and finish standard, and approved by the Architect for visual effect.

1. Extend control joints for full height and width of gypsum board installation. Do not stop joints short of termination of gypsum board.

G. Install H molding in exterior gypsum drywall construction where control joints are indicated.

3.07 FINISHING OF DRYWALL

A. General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim, and control joints; penetrations; fastener heads, surface defects and elsewhere as required to prepare Work for decoration.

B. Pre-fill open joints and rounded or beveled edges, if any, using setting type joint compound.

C. Apply joint tape at joints between gypsum boards, except where trim accessories are indicated.

D. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA 214.

1. Level 1 for ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire resistive rated assemblies and sound rated assemblies.

2. Level 2 where water resistant gypsum backing board panels form substrates for tile, and where indicated.

3. Level 3 for gypsum board surfaces indicated to receive medium or heavy textured finishes before painting.

4. Level 4 for gypsum board surfaces indicated to receive light textured finishes, wall coverings, and flat paints over light textures.

5. Level 5 for gypsum board surfaces indicated to receive gloss and semigloss enamels, non-textured flat paints, and where indicated.

E. Finish exterior gypsum soffit board by using setting type joint compounds to pre-fill joints, embed tape, and to apply first, fill (second) and finish (third) coats; smooth each coat before joint compound hardens to minimize need for sanding; sand between coats and after finish coat.
F. Base for Acoustical Tile: Where gypsum board is indicated as a base for adhesively applied acoustical tile, install tape and 2 coat compound treatment, without sanding.


H. Water Resistant Backing Board Base for Ceramic Tile: Finish joints between water resistant backing board with tape and setting type joint compound to comply with gypsum board manufacturer's recommendations and installation standards referenced in Division 09 Section “Tile.”

I. Partial Finishing: Omit third coat and sanding on concealed drywall construction which is indicated for drywall finishing or which requires finishing to achieve fire resistance rating, sound rating or to act as air or smoke barrier.

J. At all corridor partitions, smoke-stop partitions, horizontal exit enclosures, shafts and fire walls, permanently mark both sides of wall construction above ceilings to identify wall construction.
   1. Label each wall with the words "(number) HOUR (FIRE) (SMOKE) Barrier - Do Not Penetrate".
   2. Apply labeling to partition between 12 inches and 24 inches above ceiling line, located on surfaces that will not be concealed from view by subsequent construction.
   3. Where a non-rated partition is constructed in front of a rated wall and extends more than 12 inches above ceiling line, additional labeling shall be provided on the non-rated partition to identify the rated wall. [EXAMPLE: “2-Hour Fire Rated Barrier Behind This Partition - Do Not Penetrate.”].
   4. Use stencils and paint letters at least 3 inches high in permanent red ink or sign paint.
   5. For walls in excess of 20 feet long, label shall be repeated every 20 feet unless otherwise required by applicable code. For walls less than 20 feet in length, label each wall.
   6. Use vertical bold black lines with arrows designating areas of individual walls that have different ratings.

3.08 INSTALLATION OF GYPSUM BOARD SHAFT WALL SYSTEMS

A. General: Install gypsum board shaft wall systems to comply with performance and other requirements indicated as well as with manufacturer's installation instructions and the following:
   1. ASTM C 754 for installation of steel framing.
   B. Do not bridge building expansion joints with shaft wall system, frame both sides of joints with furring and other support as indicated.
   C. Install supplementary framing, blocking and bracing to support gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings and similar Work which cannot be adequately supported directly by regular framing of gypsum board shaft wall system.
1. Support elevator hoistway door frames independently of shaft wall framing system, or reinforce system in accordance with system manufacturer’s instructions.

2. Where handrails are indicated for direct attachment to gypsum board shaft wall system, provide not less than a 0.0341 inch thick by 4 inch wide galvanized steel reinforcement strip, accurately positioned and secured behind not less than one gypsum board face layer of 1/2 inch or 5/8 inch thickness.

D. Coordinate gypsum board shaft wall construction with sprayed on fireproofing of the structure, so that both remain complete and undamaged. Patch or replace sprayed on fireproofing removed or damaged during the installation of the shaft wall system.

E. Integrate stair hanger rods with gypsum board shaft wall system where indicated (and where possible); by locating cavity of system as required to enclose rods.

F. At penetrations in shaft wall, maintain fire resistance rating of entire shaft wall assembly by installing supplementary fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

G. Isolate shaft wall system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading. Comply with details shown and with manufacturer’s instructions.

H. Seal gypsum board shaft walls at perimeter of each section which abuts other Work and at joints and penetrations within each section. Install acoustical sealant to withstand dislocation by air pressure differential between shaft and external spaces; comply with manufacturer’s instructions and ASTM C 919.

I. In elevator shafts where gypsum board shaft wall system cannot be positioned within 2 inches of shaft face of structural beams, floor edges and similar projections into shaft, install 1/2 inch or 5/8 inch thick gypsum board cants covering tops of projections as follows:

   1. Slope cant panels not more than 15 degrees from vertical. Set base edge of panels in gypsum board adhesive and secure top edges to shaft walls at 24 inches on center with screws fastened to shaft wall framing.

   2. Where cants exceed 2 inches, support gypsum board with steel studs spaced 24 inches on center; extend studs from top of projection to shaft wall framing behind cant.

3.09 SHEATHING INSTALLATION

A. General: Except as otherwise indicated, comply with manufacturer’s instructions, GA 253, and the following for the installation of gypsum sheathing.

   1. Cut boards at penetrations, edges and other obstructions of the Work; fit tight against abutting Work, except provide 3/8 inch setback where non-loadbearing Work abuts structural elements at head and jambs.

   2. Coordinate installation of sheathing with installation of flashing and joint sealers so that these combined materials are installed in the sequence and manner which prevents exterior moisture from passing through completed exterior wall assembly to the interior.
3. Apply fasteners so that screw heads bear tightly against face of gypsum sheathing boards but do not cut into face paper.

4. Do not bridge building expansion joints with gypsum sheathing; cut and space edges to match spacing of structural support elements.

B. Horizontal Installation: Install 2 feet wide gypsum sheathing boards horizontally with V grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of stud flanges and stagger end joints of adjacent boards not less than one stud spacing, two where possible. Screw attach boards at perimeter and within field of board to each steel stud as follows:

1. Fasteners spaced approximately 8 inches on center and set back 3/8 inch minimum from edges and ends of boards.

2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self furring metal lath is screw attached through gypsum sheathing to studs immediately after installation of sheathing.

C. Air Infiltration Barrier Application: Cover gypsum board sheathing with air infiltration barrier as follows:

1. Cut back air infiltration barrier 1/2 inch on each side of break in supporting members at control joint locations.

2. Apply asphalt saturated organic felt horizontally with 2 inch overlap and 6 inch endlap; fasten to sheathing with corrosion resistant staples.

3. Apply plastic sheet to comply with manufacturer's printed directions.

4. Apply air infiltration barrier to cover upstanding flashing with 4 inch overlap.

3.10 APPLICATION OF TEXTURE FINISH

A. Surface Preparation and Primer: Prepare and prime drywall and other surfaces in strict accordance with texture finish manufacturer's instructions. Apply primer to all surfaces to achieve texture finish.

B. Finish Application: Mix and apply finish to drywall and other surfaces indicated to receive finish in strict accordance with manufacturer's instructions to produce a uniform texture matching Architect's sample without starved spots or other evidence of thin application, and free of application patterns.

C. Remove any texture droppings or overspray from door frames, windows and other adjoining construction.

3.11 PROTECTION

A. Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures gypsum drywall construction being without damage or deterioration at time of Substantial Completion.
END OF SECTION 09 29 00
SECTION 09 67 23 – RESINOUS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

A. This Section includes one resinous flooring system which includes a polymer grout system, a penetrating two-component epoxy primer, three-component mortar consisting of epoxy resin, curing agent and finely graded quartz silica aggregate, three-component, epoxy undercoat, brightly colored, quartz silica aggregate broadcast and a high performance, two-component, clear epoxy sealer followed by a two-component, high performance, high solids, aliphatic polyurethane coating.

1. Application Method: Troweled mortar, broadcast quartz aggregate

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1.4 QUALITY ASSURANCE

A. No request for substitution shall be considered that would change the generic type of floor system specified consisting of a minimum 3/16” troweled mortar based quartz broadcast epoxy flooring system followed by a clear, aliphatic urethane sealer. Equivalent materials of other manufacturers may be substituted only on approval of Architect or Engineer. Request for substitution will only be considered only if submitted 10 days prior to bid date. Request will be subject to specification requirements described in this section.

B. Installer Qualifications: Engage an experienced installer (applier) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

2. Contractor shall have completed at least 10 projects of similar size and complexity.
C. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer, with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

D. Manufacturer Field Technical Service Representatives: Resinous flooring manufacture shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project.
   1. Field Technical Services Representatives shall be employed by the system manufacture to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues with the installer.

E. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Apply full-thickness mockups on 48-inch- (1200-mm-) square floor area selected by Architect.
      a. Include 48-inch (1200-mm) length of integral cove base.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Pre-installation Conference:
   1. General contractor shall arrange a meeting not less than thirty days prior to starting work.
   2. Attendance:
      a. General Contractor
      b. Architect/Owner's Representative.
      c. Manufacturer/Installer's Representative.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. Samples for Verification: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.

C. Product Schedule: Use resinous flooring designations indicated in Part 2 and room designations indicated on Drawings in product schedule.

D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

E. Maintenance Data: For resinous flooring to include in maintenance manuals.
1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

   1. Retain the Subparagraph below when specifying Stonhard, Inc.'s Stonblend RTZ.

B. Maintain material and substrate temperature between 65 and 85 deg F (18 and 30 deg C) during resinous flooring application and for not less than 24 hours after application.

C. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

D. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

E. Concrete substrate shall be properly cured for a minimum of 30 days. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed prior to the resinous flooring.

1.8 WARRANTY

A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of (1) full years from date of installation, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (1) full year from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

PART 2 - PRODUCTS

2.1 RESINOUS FLOORING

A. Available Products: Subject to compliance with requirements of the following, epoxy flooring system consists of an application of a three component epoxy grout followed by a minimum 3/16" thick, penetrating two-component epoxy primer, three-component mortar consisting of epoxy resin, curing agent and finely graded quartz silica aggregate, three-component, epoxy undercoat, brightly colored, quartz silica aggregate broadcast a high performance, two-component, clear epoxy sealer and a high performance, aliphatic polyurethane coating.
B. Acceptable Manufactures,

1. Stonhard: Basis of design, Stonshield HRI with Stonseal CA7 – contact Jason Maciula 214.680.2494 or equal.

C. System Characteristics:

1. Color and Pattern: TBD

2. Wearing Surface: standard or medium texture as selected from manufacturer.

3. Integral Cove Base: TBD

4. Overall System Thickness: 3/16 inch (5 mm).

D. System Components: Manufacturer’s standard components that are compatible with each other and as follows:

1. Body Coat(s):
   a. Material Basis: HRI Mortar Base
   b. Resin: Epoxy.

2. Grout Layer:
   b. Resin: Epoxy
   c. Formulation Description: 3 component, 100% solids.

3. Topcoat:
   a. Material Basis: Stonseal CA7
   b. Resin: UV resistant aliphatic urethane
   c. Two component
   d. Number of Coats: 2

2.2 ACCESSORY MATERIALS

A. Primer: Type recommended by manufacturer for substrate and body coats indicated. Formulation Description: Stonhard Stonblend Primer, 100% solids.

B. Waterproofing Membrane: Type recommended by manufacturer for substrate and primer and body coats indicated. Use waterproofing membrane as indicated on drawings and only resinous flooring application occurs above grade. Basis of design is Stonproof ME7.

C. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
D. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for Stonflex MP7 joint fill material, and or CT5 concrete crack treatment.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Mechanically prepare substrates as follows:
   a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
   b. Comply with ASTM C 811 requirements, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.

3. Verify that concrete substrates are dry.
   a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 75 percent.
   b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 6 lb of water/1000 sq. ft. of slab in 24 hours.
   c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.

4. Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations. Allowances should be included for Stonflex MP7 joint fill material, and CT5 concrete crack treatment.
3.2 APPLICATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.
      a. Apply joint sealant to comply with manufacturer's written recommendations.

C. Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.

D. Integral Cove Base: Stonshield cove base mortar, apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
   1. Integral Cove Base: TBD inches high.

E. Troweled Mortar: Mix mortar material according to manufacturer's recommended procedures. Uniformly spread mortar over substrate using manufacturer's specially designed screed box adjusted to manufacturer's recommended height. Hand trowel apply mixed material over freshly primed substrate using steel finishing trowels or power trowel material using manufacturer's specially designed power trowel blades.

F. Surface irregularities. Mix and apply sealer with strict adherence to manufacturer's installation procedures.

G. Mar Resistant Finish: Lightly sand or scrape surface to remove any floor surface irregularities. Mix and roller apply mar resistant finish with strict adherence to manufacturer's installation procedures.

3.3 TERMINATIONS

A. Chase edges to "lock" the coating system into the concrete substrate along lines of termination.

B. Penetration Treatment: Lap and seal coating onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.

C. Trenches: Continue coating system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

D. Treat floor drains by chasing the coating to lock in place at point of termination.
3.4 JOINTS AND CRACKS

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.5 FIELD QUALITY CONTROL

A. Material Sampling: Owner may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.

   1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.

   2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.

   3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.6 CLEANING, PROTECTING AND CURING

A. Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close are of application for a minimum of 18 hours.

B. Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application. General Contractor is responsible for protection and cleaning of surfaces after final coats.

C. Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.

END OF SECTION 09 67 23
SECTION 09 91 00 – PAINTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards.

1.03 DEFINITIONS

A. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

B. “Substrate” as used herein means the surface to which paint is to be applied. In the case of previously painted existing surfaces, substrate means the surface to which the existing paint was applied.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

C. Notify the Architect of problems anticipated using the materials specified.

D. Material Quality: Provide the manufacturer's best quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers.

1.05 SUBMITTALS

A. Samples:

1. Samples for verification purposes:
a. Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

b. Define each separate coat, including block fillers and primers.

c. Use representative colors when preparing samples for review.

d. Resubmit until required sheen, color, and texture are achieved.

e. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.

f. Submit samples on the following substrates for the Architect's review of color and texture only:

1) Drywall: Provide two 12 by 12-inch samples of each color and finish.

B. Product Data:

1. Submit manufacturer's catalog cuts and descriptive information on each product used. Include preparation requirements and application instructions.

C. Record Documents: Provide record approved samples and product data.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.

2. Product description (generic classification or binder type).

3. Manufacturer's stock number and date of manufacture.

4. Contents by volume, for pigment and vehicle constituents.

5. Thinning instructions.

6. Application instructions.

7. Color name and number.

B. Store materials not in use in tightly covered containers in a well ventilated area at a minimum ambient temperature of 45 deg F (7 degrees C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.07 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).
B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C).

C. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Address</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPG Industries, Inc.</td>
<td>One PPG Place, Pittsburgh, PA 15272</td>
<td><a href="http://www.ppg.com">www.ppg.com</a></td>
</tr>
<tr>
<td>Benjamin Moore Paints</td>
<td>101Paragon Drive, Montvale, NJ 07645</td>
<td><a href="http://www.benjaminmoore.com">www.benjaminmoore.com</a></td>
</tr>
<tr>
<td>Glidden Professional</td>
<td>15885 West Sprague Road, Strongsville, OH 44136</td>
<td><a href="http://www.gliddenprofessional.com">www.gliddenprofessional.com</a></td>
</tr>
</tbody>
</table>

2.03 PAINT SCHEDULE

A. Provide the following paint systems for the various substrates, as indicated. Provide only the listed prime and finish coat materials unless otherwise recommended in writing by the paint manufacturer for each specific substrate.

B. Where specific finish paint material is not indicated, refer to notes and finish schedules for finish paint material and gloss levels for each surface to be painted.

2.04 INTERIOR PAINTING SCHEDULE

A. Gypsum Drywall; 2 finish coats over primer:

1. Primer:
   a. PPG: Speedhide Zero Interior Latex Primer 6-4900.
   b. Benjamin Moore: Fresh Start Primer 023 All Purpose 100% Acrylic Latex.
   c. Glidden Professional: Lifemaster LM 9116 0 VOC Primer.

2. Finish Coat:
   a. PPG: Speedhide Zero Interior Latex Eggshell 6-4310.

B. Ferrous Metal; 2 finish coats of water borne semi-gloss acrylic latex enamel over primer:

1. Waterborne Acrylic Primer:
   a. PPG: Pitt-Tech 100 percent Acrylic Primer 90-712.
   c. Glidden Professional: Devflex 4020 PF Direct to Metal Primer and Flat Finish.

2. Finish Coat:
   a. PPG: Pitt-Tech 100 percent Acrylic Satin Direct to Metal 90-474.

C. Galvanized Metal; 2 finish coats of water borne semi-gloss acrylic latex enamel over primer:

1. Waterborne Acrylic Galvanized Metal Primer:
   a. PPG: Pitt-Tech 100 percent Acrylic Primer 90-712.
   c. Glidden Professional: Devflex 4020 PF Direct to Metal Primer and Flat Finish.

2. Finish Coat:
   a. PPG: Pitt-Tech 100 percent Acrylic Satin Direct to Metal 90-474.

D. Aluminum: 2 finish coats of water borne acrylic latex enamel over primer:

1. Waterborne Acrylic Galvanized Metal Primer:
   a. PPG: Pitt-Tech 100 percent Acrylic Primer 90-712.
   c. Glidden Professional: Devflex 4020 PF Direct to Metal Primer and Flat Finish.

2. Finish Coat:
   a. PPG: Pitt-Tech 100 percent Acrylic Satin Direct to Metal 90-474.
E. Wood; 2 finish coats over primer:

1. Primer:
   b. Benjamin Moore: 046 BM Fresh Start All 100% Acrylic Superior Primer.
   c. Glidden Professional: Lifemaster 9116 0 VOC Primer.

2. Finish Coat:
   c. Glidden Professional: 9300 Lifemaster 0 VOC Interior Eggshell.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.

1. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.

1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers and existing surfaces, or remove and reprime. Notify Architect in writing of problems anticipated with using the specified finish coat material with substrates primed by others.
   a. Use abrasive blast cleaning methods if recommended by the paint manufacturer.
   b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
2. Ferrous Metals: Clean non-galvanized ferrous metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council.
   a. Touch up bare areas and shop applied prime coats that have been damaged. Wire brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

3. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.
   1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
   2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
   3. Use only thinners approved by the paint manufacturer, and only within recommended limits.

3.02 INSTALLATION
   A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
   B. All installation shall be in accordance with manufacturer's published recommendations

3.03 APPLICATION
   A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
   B. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.
      1. Painting of mechanical, electrical, and plumbing items is limited to exposed natural gas piping, exposed fire sprinkler piping, and roof top exhaust fan hoods. Items in mechanical and electrical rooms shall not be field painted unless otherwise scheduled on Drawings.
   C. At "unoccupied" interior areas, painting is not required on prefinished items or finished metal surfaces.
      1. Do not paint over Underwriter's Laboratories, Factory Mutual or other code required labels or equipment name, identification, performance rating, or nomenclature plates.
D. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

1. Paint colors, surface treatments, and finishes are indicated in "schedules."

2. Provide finish coats that are compatible with primers used.

3. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.

4. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.

5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.

6. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.

7. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint.

8. Sand lightly between each succeeding enamel or varnish coat.

9. Omit primer on metal surfaces that have been shop primed and touch up painted.

E. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

F. Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer.

G. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

3.04 CLEANING

A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
B. Upon completion of painting, clean glass and paint spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

3.05 PROTECTION

A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.

B. Provide “wet paint” signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 09 91 00
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Basic and supplemental requirements common to Fire Suppression, Plumbing and HVAC Work.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the Contract Documents.

1.04 DEFINITIONS

A. These definitions are included to clarify the direction and intention of these Specifications. For further clarification, contact the Architect/Engineer.

1. Concealed / Exposed: "Concealed" areas are those areas that cannot be seen by the building occupants. "Exposed" areas are all areas, which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms. "Exterior" areas are those that are outside the building exterior envelope and exposed to the outdoors.

2. Furnish: The term "furnish" is used to mean "supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.

3. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

4. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
1.05 QUALITY ASSURANCE

A. Fire Suppression, Plumbing and HVAC systems shall be coordinated with other systems and trades to include but not be limited to: Electrical systems, fire alarm, security systems, transport systems, telephone and data systems.

B. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of Contractor’s Work to the building structure and to the Work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the Work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any Work. Adjustments to the Work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

C. All dimensional information related to new structures shall be taken from the appropriate Drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the Site.

D. The Drawings are subject to the requirements of Reference Standards, structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of Work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

E. When the Drawings do not give exact details as to the elevation of pipe and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping and duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

F. Where core drilling of floor or wall penetrations is required, Work shall be performed in accordance with Division 03 Specifications. Where applicable Division 03 Specifications are not included in the Project, core drilling shall be in accordance with generally accepted standards, and be performed by licensed personnel where applicable.

G. Certify in writing that neither the Contractor nor any of Contractor’s subcontractors or suppliers will supply any materials that contain any asbestos in any form for this Project.

1.06 DELIVERY, STORAGE AND HANDLING

A. All equipment, ductwork, and materials shall be delivered to the Project Site clean and sealed for protection.

B. Take particular care not to damage the existing construction in performing Work. All finished floors, step treads and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the Project.
C. Equipment and materials shall be protected from rust and dust/debris both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.

D. All material affected by weather shall be covered and protected to keep the material free from damage while material is being transported to the Site and while stored at the Project Site.

E. During the execution of the Work, open ends of all piping and conduit, and all openings in equipment shall be closed when Work is not in progress, and shall be capped and sealed prior to completion of final connections, so as to prevent the entrance of foreign matter.

F. All equipment shall be protected during the execution of the Work. All ductwork and equipment shall be sealed with heavy plastic and tape to prevent build-up of dust and debris.

G. All ductwork and air handling equipment shall be wiped down with a damp cloth immediately before installation to ensure complete removal of accumulated dusts and foreign matter.

H. All plumbing fixtures shall be protected and covered to prohibit usage. All drains shall be covered until placed in service to prevent the entrance of foreign matter.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.

C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.

E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.
2.02 NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters.

C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

D. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.

1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.03 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes, ducts, conduits, etc., passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.

B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.

C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.

D. Plates will not be required for piping where pipe sleeves extend ¾-inch or more above finished floor.

E. Round and rectangular ducts shall have closure plates (not chrome plated) made to fit accurately at all floor, wall and ceiling penetrations.

2.04 ROOF PENETRATIONS AND FLASHING

A. Pipe, conduit and duct sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 - EXECUTION

3.01 PREPARATION

A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.
B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

D. Space Requirements:

1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

E. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

F. Connections for equipment other than Divisions 21, 22, 23:

1. Rough-in and provide all gas, air, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., furnished by the Owner and/or other trades in accordance with detailed rough-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

2. After the equipment is set in place, make all final connections and provide all required pipe, fittings, valves, traps, etc.

3. Provide all backflow preventers and air gap fittings required, using approved devices. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.

4. Provide all ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor’s closets, tight against pan soffits in exposed “tee” structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.
D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify the Owner’s Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be “sealed” off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.

F. Precedence of Materials:

1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.

2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the “Right of Way”:
   a. Building lines
   b. Structural members
   c. Structural support frames supporting ceiling equipment
   d. Electric tracked vehicle system
   e. Pneumatic trash and linen system
   f. Pneumatic tube system
   g. Soil and drain piping
   h. Vent piping
   i. Supply, return and outside air ductwork
   j. Exhaust ductwork
   k. HVAC water and steam piping
   l. Condensate piping
   m. Fire protection piping
   n. Natural gas piping
   o. Medical/Laboratory gases
   p. Domestic water (cold and hot, softened, treated)
   q. Refrigerant piping
3. Coordinate fire suppression, plumbing and HVAC systems with transport systems as required to maintain transport system right-of-way.

3.03 TESTING

A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has the Owner’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.

B. 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 acceptance and performance certification will be the same date.

C. Before the Work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of manufacturer’s materials and/or equipment to determine that materials and/or equipment are properly installed and in proper operating order. The qualifications of the manufacturer’s representative shall be appropriate to the technical requirements of the installation. The qualifications of the manufacturer’s representative shall be submitted to the Owner for approval. The decision of the Owner concerning the appropriateness of the manufacturer’s representative shall be final. Testing and checking shall be accomplished during the course of the Work where required by Work being concealed, and at the completion of the Work. In addition, the Contractor shall submit to the Architect/Engineer a signed statement from each manufacturer’s representative certifying as follows: “I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer’s representative and is properly installed and operating in accordance with the manufacturer’s recommendations.”

D. Check inspections shall include piping, equipment, heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

E. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.

F. Notify the Owner’s Project Manager and the Architect/Engineer in writing at least seven (7) calendar days prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.
G. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspects, description of the test and extent of system tested, test conditions, test results, specified results and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under “Requirements for Final Acceptance.” The Contractor or Contractor’s authorized job superintendent shall legibly sign all Test Log entries.

H. Refer to Commissioning Specification Sections for additional Start-up, prefunctional and operational checkout, and for functional performance test procedures.

3.04 TRAINING

A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled “Project Closeout Procedures.”

B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

END OF SECTION 20 01 00
SECTION 20 05 29 – SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install supports, hangers, anchors, sleeves and bases for all pipe, duct, equipment, system components and accessories, indicated by the Contract Documents with all supplementary items necessary for complete, code compliant and approved installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. International Mechanical Code.
4. ASME B31.2 - Fuel Gas Piping.
5. ASME B31.9 - Building Services Piping.
6. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
7. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
8. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
9. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
10. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.
12. NFPA 14 - Installation of Standpipe and Hose Systems.
15. SMACNA - HVAC Duct Construction Standards.
16. Underwriters Laboratories Standards and Listings.

1.04 QUALITY ASSURANCE

A. Materials and application of pipe hangers and supports shall be in accordance with MSS-SP-58 and SP-69 unless noted otherwise.

B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.

C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five.

D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is experienced in installation of Work similar to that required for this Project and per the minimum requirements of MSS SP-89. Field welding of supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum requirements of MSS SP-58.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's catalog data including code compliance, load capacity, and intended application.

B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

C. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of Texas registered professional engineer. Indicate size and characteristics of components and fabrication details and all loads exceeding 250 pounds imposed on the base building structure.

1.06 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

B. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.

C. Store materials protected from exposure to harmful weather conditions.
PART 2 - PRODUCTS

2.01 GENERAL
A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS
A. Hangers and Supports:
   1. Anvil International.
   2. Kinder.
   3. Cooper B-Line.
   5. Hubbard Enterprises/Holdrite
   7. Power Strut.

2.03 HANGERS AND SUPPORTS
A. General:
   1. Refer to individual system and equipment Specification Sections for additional support requirements. Comply with MSS SP-69 for support selections and applications that are not addressed within these Specifications.
   2. Utilize hangers and supports to support systems under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses from being introduced into the structure, piping or connected equipment.
   3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
   4. Design hangers to impede disengagement by movement of supported pipe.
   5. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
   6. Wire or perforated strap iron will not be acceptable as hanger material.
   7. Hanger rods shall be threaded on both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
8. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.

9. Nail drive anchors, plastic anchors or plastic expansion shields will not be permitted under any circumstances.

10. Hangers and clamps supporting and contacting individual non-insulated brass or copper lines shall be copper or copper plated. Support individual non-insulated brass or copper lines 4 inches and smaller with adjustable swivel ring hangers. Where non-insulated brass or copper lines are supported on trapeze hangers or channels, the pipes shall be isolated from these supports with approved flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp. Plastic tape is not acceptable.

11. Hangers and clamps supporting and contacting glass piping shall be in accordance with the piping manufacturer’s published recommendations and shall be fully lined with minimum 1/4 inch neoprene padding. The padding material and the configuration of its installation shall be submitted for approval.

12. Hangers and clamps supporting and contacting plastic piping shall be in accordance with the piping manufacturer’s published recommendations and shall be factory coated or padded to prevent damage to piping.

13. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

B. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-corrosive environments, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. All hangers and supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or manufactured from materials that will not rust or corrode due to moisture. All hangers and supports located within corrosive environments shall be constructed from or coated with materials manufactured for installation within the particular environment.

C. Vertical Piping:

1. Supports for vertical riser piping in concealed areas shall utilize double bolt riser clamps, with each end having equal bearing on the building structure at each floor level.

2. Supports for vertical riser piping at floor levels in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the penetrated structure utilizing drilled anchors, two hanger rods (sized as specified), and socket clamp with washers.

3. Two-hole rigid pipe clamps or four-hole socket clamps with washers may be used to support pipe directly from adequate structural members where floor-to-floor distance exceeds required vertical support spacing and lines are not subject to expansion and contraction.
D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on manufactured channel, suspended on rods or pipes. Trapeze members including suspension rods shall be properly sized for the quantity, diameters, and loaded weight of the lines they are to support.

E. Ductwork: All ductwork shall be supported in accordance with SMACNA recommendations for the service involved. Horizontal ducts supported using galvanized steel bands shall extend up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete, bolted to angles secured to the construction above, or secured in another approved manner.

F. Terminal Units:

1. Terminal units weighing up to 150 pounds shall be supported by four (4) 1 inch wide sheet metal straps with ends turned under bottom of unit at corners.

2. Each band shall be secured by not over 3/4 inch in length, 1/4 inch diameter sheet metal screws – two (2) on bottom of unit and one (1) on each side.

3. The other strap end shall be attached to the structure by 1/4 inch diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor.

4. Where interference occurs, overhead of the box, not allowing direct vertical support by straps, provide trapeze channels suspended by 1/4 inch diameter galvanized threaded rods providing such channels do not block access panels of units.

5. Terminal units weighing more than 150 pounds shall be supported per the terminal unit manufacturer’s installation instructions using threaded rod and hanger brackets located per manufacturer’s drawing.

G. Fixture and Equipment Service Piping:

1. Piping at local connections to plumbing fixtures and equipment shall be supported to prevent the weight of the piping from being transmitted to fixtures and equipment.

2. 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 systems, C & S Mfg. Corp. or Owner-approved equivalent.

3. Supports within chases and partitions shall be corrosion resistant metal plate, clamps, angles or channels, and aligned with structure in the vertical or horizontal position. Plastic supports are not allowed unless approved by Owner.

4. Horizontal supports within chases and partitions that are attached to studs shall be attached at both ends. Drywall shall not be relied upon to support the piping.

5. Supports for plumbing fixture water service piping within chases and partitions may be attached to cast iron drain and vent pipe with approved brackets and pipe clamps.

6. Piping exposed on the face of drywall shall be supported with corrosion resistant metal channels that are attached to wall studs. Drywall shall not be relied upon to support the piping.
7. Piping supported from the floor shall utilize corrosion resistant metal channels or brackets that are anchored to the floor slab.

8. All water piping shall be isolated from building components to prevent the transmission of sound.

9. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action. Plastic tape is not an acceptable isolation material.

H. Fire Protection Piping: All hangers and supports for fire standpipe systems and fire sprinkler systems shall be Factory Mutual and Underwriters' Laboratories, Inc. listed and labeled.

I. Inserts:


2. Inserts shall have malleable iron case with galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval.

3. Manufactured inserts for metal deck construction shall have legs custom fit to rest in form valleys.

4. Shop fabricated inserts shall be submitted and approved by Owner prior to installation.

5. Inserts shall be of a type that will not interfere with structural reinforcing and that will not displace excessive amounts of structural concrete.

J. Pipe Shields: Provide pipe shields in accordance with insulation manufacturer’s published recommendations. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier.

K. Housekeeping Pads:

1. Provide minimum 4 inch reinforced concrete pads with chamfered corners and equipment bases for all outdoor equipment on grade, floor mounted equipment in main central plant area, mechanical rooms, areas with floors below grade, penthouse equipment rooms, floor mounted air handling units, and where shown on Drawings.

2. Housekeeping pads shall extend minimum of 4 inch on all sides beyond the limits of the mounted equipment unless otherwise noted.

3. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the equipment manufacturer.

2.04 PIPE AND DUCT PENETRATIONS

A. General:
1. Seal penetrations through all rated partitions, walls and floors with U.L. tested assemblies to provide and maintain a rating equal to or greater than the partition, wall or floor.

2. Inside diameter of all sleeves or cored holes shall provide sufficient annular space between outside diameter of pipe, duct or insulation to allow proper installation of required fire and water proofing materials and allow for movement due to expansion and contraction.

3. Exposed ceiling, floor and wall pipe penetrations within finished areas (including exterior wall faces) shall be provided with chrome plated, brass or stamped steel, hinged, split-ring escutcheon with set screw or snap-on type. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings. In exterior, damp, or corrosive environments, use Type 302 stainless steel escutcheons.

B. Floor Pipe Penetrations:

1. Seal penetrations through all floors to provide and maintain a watertight installation.

2. Sleeves cast in the slab for pipe penetrations shall be Schedule 40 steel, ASTM A53, with 2 inch wide annular fin water-stop continuously welded at midpoint of slab. Entire assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.

3. Cored holes in the slab for pipe penetrations shall be provided with a Schedule 40 steel, ASTM A53 sleeve, with 2 inch wide annular fin water-stop continuously welded at point on sleeve to allow countersinking into slab and waterproofing. Entire sleeve assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.

4. All sleeves shall extend a minimum of two inches above finished floor.

5. Where job conditions prevent the use of a sleeve that extends two inches above the slab, Link-Seal mechanical casing seals manufactured by Thunderline Corporation may be installed to provide a watertight penetration. Mechanical casing seals can be used only for relatively small diameter pipe penetrations. Verify that slab thickness allows proper installation of the link-seal assembly and the required fire stopping prior to applying this exception.

C. Wall Penetrations:

1. Where piping or ductwork passes through non-rated partition, close off space between pipe or duct and construction with gypsum wallboard and repair plaster smoothed and finished to match adjacent wall area.

2. Pipe penetrations through interior rated partitions shall be provided with adjustable prefabricated U.L. listed fire rated galvanized sheet metal sleeves having gauge thickness as required by wall fire rating, 20 gauge minimum. EXCEPTION: When U.L. Listed assembly does not require a sleeve,

3. Pipe penetrations through exterior walls and walls below grade shall be provided with “Link-Seal” mechanical casing seal manufactured by Thunderline Corporation.
4. Ductwork penetrations through rated partitions, walls and floors shall be provided with sleeves that are manufactured integral with the damper assembly installed.

D. Flashing:
   1. Coordinate flashing material and installation required for pipe and duct roof penetrations with Owner and roofing Contractor.
   2. Provide flexible flashing and metal counter-flashing where ductwork penetrates exterior walls. Seal penetration water and air tight.
   3. Provide acoustical flashing around ducts and pipes penetrating equipment rooms, with materials and installation in accordance with manufacturer's instructions for sound control.

E. Roof Curbs: Coordinate roof curb material and installation with Owner and roofing Contractor.

PART 3 - EXECUTION

3.01 PREPARATION
   A. Conduct a pre-installation meeting prior to commencing Work of this Section to verify Project requirements, coordinate with other trades, establish condition and completeness of substrate, review manufacturer's installation instructions and manufacturer's warranty requirements.

3.02 INSTALLATION
   A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
   B. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with manufacturer's printed installation instructions.
   C. Provide for vertical adjustments after erection and during commissioning, where feasible, to ensure pipe is at design elevation and slope.
   D. Install hangers and supports to allow controlled thermal movement of piping systems, permitting freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   E. Install hanger so that rod is vertical under operating conditions.
   F. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
   G. 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 that holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required. Contractor shall be responsible for engaging a structural engineer as required for design and review at support systems.
H. Do not hang pipe, duct or any mechanical/plumbing item directly from a metal deck or locate on the bottom chord of any truss or joist unless approved by the Structural Engineer of Record.

I. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.

J. Piping supports shall be independent from ductwork supports. Combining supports is not permitted.

K. Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the Drawings.

L. All piping and ductwork supports shall be designed and installed to allow the insulation to be continuous through the hangers.

M. Adjustable clevis hangers shall be supported at rods with a nut above and below the hanger.

N. All hanger rods shall be trimmed neatly so that 1 inch 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.

O. Install hangers to provide minimum ½ inch space between finished covering and adjacent structures, materials, etc.

P. Horizontal and vertical piping in chases and partitions shall be supported to prevent movement and isolated from the supports to prevent transmission of sound.

Q. Locate hangers within 12 inches of each horizontal elbow.

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

S. Support riser piping independently of connected horizontal piping. Riser piping is defined as vertical piping extending through more than one floor level.

T. Support riser piping at each floor level and provide additional supports where floor-to-floor distance exceeds required vertical support spacing. Installation of riser clamps and welded steel riser supports shall not allow weight of piping to be transmitted to floor sleeves.

U. Steel Bar Joists: Hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded or otherwise permanently fixed to the top of joists.

V. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
W. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. attached to the precast, double tee, structural concrete system shall be installed in accordance with approved Shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4 inch larger than the diameter of the hanger rod. Hanger rods shall supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15 inches of each stem and in the "shadow" of the stem on the top side of the "double tees".

X. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Y. Inserts:

1. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

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

3. Install anchors in concrete after concrete is placed and completely cured. Install anchors according to manufacturer's written instructions.

Z. Flashing:

1. Coordinate all roof flashing with requirements of Division 07.

AA. Pipe Shields:

1. Provide shields at each hanger supporting insulated pipe.

2. Provide shields of the proper length to distribute weight evenly and to prevent compression of insulation at hanger.

3. Install shield so that hanger is located at the center of the shield.

4. Attach shield to insulation with adhesive to prevent slippage or movement.

BB. Equipment Anchor Bolts:

1. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of sufficient size to provide ½ inch clearance around bolt.

END OF SECTION 20 05 29
SECTION 20 05 48 – VIBRATION ISOLATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install inertia bases and vibration isolation indicated by the Contract Documents with supplementary items necessary for their proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

   1. ASHRAE - Guide to Average Noise Criteria Curves.

1.04 QUALITY ASSURANCE

A. Provide for vibration isolation supports for all equipment, piping and ductwork indicated herein. The transmission of perceptible vibration, structural borne noise or objectionable air borne noise to occupied areas by equipment installed under this Contract will not be permitted. Install vibration isolators as specified herein or shown on the Drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas.

B. The vibration isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria; and one that can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

C. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

D. Provide vibration isolation devices, from a single manufacturer or supplier who will be responsible for complete coordination of all phases of this Work.

1.05 SUBMITTALS

A. Product Data:
1. Submit Shop Drawings, installation instructions, and product data.

2. Indicate vibration isolator locations, with static and dynamic load on each, on Shop Drawings and described on product data.

3. Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type and deflection of each isolator; and the supported weight, disturbing frequency and efficiency of each isolator proposed; and any calculations and other information as may be required for the Architect/Engineer to check the isolator selection for compliance with the specification.

B. Record Documents:

1. Indicate inertia bases on Shop Drawings, including dimensions.

2. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall clearly indicate outlined procedures for installing and adjusting the isolators and bases mentioned above.

3. Submittals on riser isolation system shall show initial and final loads on the structure at each support point, initial and final deflection of each isolator, amount and direction of each deflection change, total expansion and contraction of each riser and operating temperature of 180 degrees F in the riser.

4. Riser diagrams shall be prepared by the vibration isolation manufacturer and submitted for approval. These diagrams shall show initial and final spring deflections, amount and direction of deflection changes, overall expansion and contraction of the riser, and operating temperature of the medium.

5. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the design proposed when installed in accordance with submittal and these Specifications.

C. Operation and Maintenance Data:

1. Provide manufacturer’s recommended maintenance procedures.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All vibration isolators and bases shall be designed for and treated for resistance to corrosion.

C. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cadmium plated.

D. All isolators exposed to the weather shall have steel parts hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.
E. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these Specifications, but in no case shall be less than one inch. Springs shall be capable of 30 percent over-travel before becoming solid.

F. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2 inches under the isolated structure and designed so that the isolators can be installed and removed when the operating clearance is 2 inches or less. When used with spring isolators having a deflection of 2-1/2 inches or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

G. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1 inch to 2 inches.

H. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

I. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 pounds per square foot applied to any exposed surface of the equipment without failure.

2.02 MANUFACTURERS

A. The VMC Group

B. Consolidated Kinetics.

C. Mason Industries

D. Vibration Eliminator.

2.03 ISOLATION BASES

A. Type SFB: A structural steel fan and motor base with NEMA standard motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive.

B. Type CPF: Concrete inertia base, consisting of full depth perimeter steel pouring form, 3000 psi concrete reinforcing bars welded in place, bolting templates with anchor bolts and height-saving brackets for side mounting of the isolators. The base shall be sized with a minimum overlap of 4 inches around the base of the equipment. Fan bases are to be supplied with NEMA standard motor slide rails.

C. The bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

D. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.
2.04 ISOLATOR TYPES

A. Isolator types and required deflections are specified under “Application.” Isolator type designations are The VMC Group designators. The isolators shall comply with the following descriptions for each type required on the Project:

1. Type XL: Aluminum-housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Steel or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of ¼ inch shall be bonded to the baseplate.

2. Type SW: Adjustable, freestanding, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring mounting to baseplate and compression plate must be rigid. The neoprene pad with a minimum thickness of ¼ inch is bonded to the baseplate. A minimum horizontal-to-vertical spring rate of 1.0 is required.

3. Type BS: Spring hanger consisting of a rectangular steel box, coil spring, spring retainers, neoprene-impregnated fabric washer and steel washer.

4. Type BSA: Spring hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, coil spring, spring retainers, neoprene impregnated fabric washer and steel washer. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

5. Type BSR: Combination spring and rubber hanger consisting of a rectangular steel box, coil spring, spring retainers and elastomeric mounting designed for ½ inch deflection.

6. Type BSRA: Combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, coil spring, spring retainers and elastomeric element. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

7. Type RSW: Adjustable spring isolator as describe for Type SW with the addition of a fabricated steel housing suitable for recessing into a concrete inertia block. The housing has a side access.

8. Type PBS: Spring hanger as described for Type BS with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation.

9. Type PBSA: Spring hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation, and to permit transferring the load to the spring after installation, a coil spring, spring retainers, neoprene impregnated fabric washer and steel washer. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.
10. PBSR: Combination spring and elastomeric hanger as described for Type BSR with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation.

11. Type PBSRA: Combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation, a coil spring, spring retainers and elastomeric element. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

12. Type CT: Adjustable, open-spring isolator having one or more coil springs attached to a top compression plate and a base plate. A neoprene pad with a minimum thickness of ¼ inch is bonded to the base plate. The spring assembly must fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. The isolator includes restraining bolts for connecting the top plate and lower housing to prevent the isolated equipment from rising when drained of water.

13. Type SP-NRE: Pad-type mounting consisting of two layers of 3/8 inch thick ribbed or waffled neoprene pads bonded to a 16 gauge galvanized steel separator plate. Size pads for approximately 20 to 40 psi load and a deflection of 0.12 to 0.16 inch.

14. Type BRD: Elastomeric hanger consisting of a rectangular steel box and an elastomeric isolation element of neoprene. A high-quality synthetic rubber may be used if it contains antiozone and antioxidant additives. The elements are designed for approximately ½ inch deflection and loaded so that the deflection does not exceed 15 percent of the free height of the element.

15. Type TRK: For static pressure of 3 inch water or greater, provide a set of spring-loaded thrust resistors (two or more) installed across the flexible duct connection on the fan discharge, designed to limit the movement of the fan. Coil spring static deflection capabilities of thrust resistors shall equal those of the isolators supporting the equipment up to a maximum of 2 inches.

16. Type RVD: An elastomeric mounting having a steel baseplate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately ½ inch deflection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install motor driven equipment with vibration isolators.

D. Set steel bases for one-inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch clearance. Adjust equipment level.
E. Isolate pumped water-piping systems with spring-type vibration isolators to produce a floating mechanical system. Provide spring isolators on piping connected to isolated equipment as follows: Static deflection for the two supports closest to equipment on each pipe connected to the equipment shall be equal to the deflection of isolated equipment. All other supports for horizontal piping shall have a minimum operating deflection of ¾ inch with a capability of an additional 50 percent travel to solid.

F. All open-type spring isolators shall be restrained as recommended by the manufacturer.

G. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, shall be mounted on the scheduled vibration isolator type to prevent transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. After piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. Isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length that will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load. All springs supporting piping that is connected to a piece of isolated equipment shall be sized for static deflection equal to that of the isolated equipment.

H. Piping (Including Generator Piping):

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.

2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

4. All springs supporting piping shall be capable of an additional ½ inch deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.

5. Support risers up through 16 inches at every third floor, and risers 18 inches and over at every second floor. All supports for risers must have a deflection capability at least four times the anticipated expansion and contraction. Install temporary anchors as required to permit preadjustment of springs in the risers. Furnish permanent limit stops to prevent excessive vertical motion of risers in the event risers are drained. Wall sleeves for takeoffs from risers shall be sized for insulation outside diameter plus two times the calculated thermal movement to prevent binding.

6. System operating temperatures (degrees F) are as follows:
Resilient Sleeves: Resilient sleeves shall be provided at all points where equipment room walls, floors or ceilings are penetrated by ducts, piping or refrigerant line, etc.

Fans and Air Handling Units: Such units shall have electrical flexible connections not less than 36 inches long and the flexible duct connections with a free length of not less than 8 inches.

Ductwork: Isolate all high pressure ductwork within each equipment room and to a minimum of 50 feet from fan with Type BS hangers or Type SW floor supports, sized for ¾ inch deflection.

To prevent excessive transfer of piping load from floor to floor, all water riser support springs shall have a deflection capability of four times the expansion or contraction to be accommodated by the support with the additional runout capability to absorb the movement. Isolators supporting steam and diesel engine exhaust risers shall be selected for deflections equal to two times the anticipated thermal movement at the support point. Riser isolation system shall be designed such that it supports the riser in tension, eliminating the need for guides; requires no anchors; and has a zero movement point at or near the center to divide thermal movement approximately in half, thus reducing vertical movement of horizontal pipe takeoffs.

3.02 APPLICATION

The following is a schedule of equipment on a typical project that requires vibration isolation and base isolators of the types specified. Refer to Drawings for equipment scheduled for the Project. Any equipment, system or condition that may be altered, added, or changed; or that is not specifically described in the Contract Documents shall be isolated in a manner specified for similar equipment, system or condition in order to comply with these Specifications.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Isolator Type/Minimum Deflection (Inches)</th>
<th>Base Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Handling Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Mounted – Up to 15 HP</td>
<td>SW 2&quot;</td>
<td>N/A</td>
</tr>
<tr>
<td>Floor Mounted – 15 HP and Over</td>
<td>SW 2.4&quot;</td>
<td>N/A</td>
</tr>
<tr>
<td>Suspended – Up to 15 HP</td>
<td>PBSRA 2&quot;</td>
<td>SFB</td>
</tr>
<tr>
<td>Suspended – 15 HP and Over</td>
<td>PBSRA 3.5&quot;</td>
<td>SFB</td>
</tr>
<tr>
<td>High pressure Fan Sections</td>
<td>SW 2&quot; with TRK 3.5</td>
<td>CPF</td>
</tr>
<tr>
<td>Fan Coil Units – Suspended</td>
<td>PBSRA 1&quot;</td>
<td>N/A</td>
</tr>
<tr>
<td>Fan Powered Terminal Units Not Internally Isolated</td>
<td>PBSRA 1&quot;</td>
<td>N/A</td>
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<tr>
<td>Centrifugal Fans</td>
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<td></td>
</tr>
<tr>
<td>Class I and II – Up to 54-¼ inch Diameter Up to 15 HP</td>
<td>SW 2&quot;</td>
<td>SFB (If required)</td>
</tr>
<tr>
<td>Class I and II – 60-inch Diameter and Over, 15 HP and Over</td>
<td>SW 4.5&quot;</td>
<td>SFB (If required)</td>
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<td>Class III – All sizes</td>
<td>SW 3.5&quot; with TRK 2&quot;</td>
<td>CPF</td>
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<td>Equipment Type</td>
<td>Isolator Type/ Minimum Deflection (Inches)</td>
<td>Base Type</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------------------------------</td>
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</tr>
<tr>
<td>Arrangement # 3 Fans</td>
<td>SW 4.5”</td>
<td>SFB</td>
</tr>
<tr>
<td>Vane Axial Fans</td>
<td>SW 4.5” with TRK 2”</td>
<td>SFB</td>
</tr>
<tr>
<td>Vent Sets:</td>
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<td></td>
</tr>
<tr>
<td>Floor Mounted – Up to 15 HP</td>
<td>SW 1.5”</td>
<td>SFB (If required)</td>
</tr>
<tr>
<td>Suspended – Up to 15 HP</td>
<td>PBSRA 1.5”</td>
<td>SFB (If required)</td>
</tr>
<tr>
<td>Unit Substations</td>
<td>RVD 0.5”</td>
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<tr>
<td>Compressors</td>
<td>CT 1.5”</td>
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<tr>
<td>Engine Driven Generators:</td>
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<td></td>
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<tr>
<td>Skid Mounted</td>
<td>CT 3”</td>
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<tr>
<td>Exhaust Pipe</td>
<td>PBSRA 3”</td>
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<td>Pumps:</td>
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<tr>
<td>Up to 5 HP</td>
<td>RSW 0.5”</td>
<td>CPF</td>
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<tr>
<td>5 HP to 10 HP</td>
<td>RSW 1”</td>
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<tr>
<td>10 HP and Over</td>
<td>RSW 2”</td>
<td>CPF</td>
</tr>
<tr>
<td>Vacuum Pumps</td>
<td>RSW 1”</td>
<td>CPF</td>
</tr>
</tbody>
</table>

B. Piping Application:

1. Type PBSRA for hangers in all horizontal piping at equipment; except at connections to risers use BS.

2. Type SW for all floor supports of floor supported piping at equipment or stanchion.

END OF SECTION 20 05 48
SECTION 20 05 53 – PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install Owner’s equipment tags, fire damper tags, valve tags, stencils, and pipe markers indicated by the Contract Documents with supplementary items necessary for proper installation.

B. Contractor shall make it possible for Owner’s operations and maintenance personnel to readily identify the various pieces of equipment, valves, piping, ductwork, fire dampers etc., by marking them in accordance with this Specification.

C. Clearly mark all items of equipment, including but not limited to, fans, pumps, fire dampers, and valves using equipment tags as specified in this Section. The tagged item of equipment shall correspond to the same number as shown on the Drawings and as listed in the Equipment Matrix. Download an electronic version of the Equipment Matrix in Microsoft Excel format to use as a template for submittal purposes at the following website:

http://www2.mdanderson.org/depts/cpm/standards/templates/EquipmentMatrixTemplate.xlsx

D. Refer to Specification Section 01 91 00, General Commissioning Requirements, for a detailed description of Equipment Matrix information.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:


1.04 SUBMITTALS

A. Product Data:

1. Provide manufacturer’s catalog literature for each product.

B. Record Documents:

1. Submit Equipment Matrix with Valve and Fire Damper schedules completed..xlsx

C. Operation and Maintenance Data:

1. Manufacturer’s Installation Instructions: Indicate special procedures and installation.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Equipment Tags, Valve Tags, and Markers:

1. Marking Systems, Inc.

2. Seton Name Plate Company.


4. Graphic Products, Inc.

2.03 EQUIPMENT AND FIRE DAMPER TAGS

A. Description: 3” x 4” vinyl label, 3.0 Mil self-adhesive vinyl similar to DuraLabel Pro. Label color shall be black text on a white background. The label shall contain the following information per the template, described in Attachment “B”:

1. Asset Short Description As listed in Equipment Matrix.

2. Asset Number: As listed in Equipment Matrix.

3. Asset Location: As listed in Equipment Matrix.


B. All scheduled equipment shall be identified with an Equipment Tag.
2.04 VALVE TAGS


B. Valve tags shall be black ABS plastic tags: Injected molded ABS plastic, 3.375” X 4.75” with self-adhesive vinyl label, similar to DuraLabel Pro, affixed to valve tag. Each tag shall be attached to its valve with one tie strap.

C. Vinyl Label: 3.0 Mil self-adhesive vinyl similar to DuraLabel Pro. Label color shall be as per the standard designated colors listed in the attachment to this specification. The label shall contain the following information as per template, refer to Attachment “B”:

1. Asset Short Description: As listed in Equipment Matrix.
2. Asset Number: As listed in Equipment Matrix.
3. Asset Location: As listed in Equipment Matrix.

D. Each valve shall be named as per attached valve tag naming convention, refer to Attachment “C”.

E. In addition to valve tags, valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall be tagged with standardized color coded plastic tags. Each tag shall be attached to its valve with one tie strap. These tags shall be 2-½ inches wide by 1-½ inches high with these color codings:

1. Red = normally closed.
2. Green = normally open.
3. Blue = open in winter, closed in summer.
4. Yellow = closed in winter, open in summer.

F. Valve Tag Fasteners: Single ABS plastic tie strap.

2.05 PIPE AND DUCT MARKERS

A. Round Pipe and Duct Markers shall conform to ANSI A13.1-2007 "Scheme for the Identification of Piping Systems", refer to Attachment “A” for abbreviation and label color designations. Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

B. Rectangular Duct Stencils shall conform to ANSI A13.1-2007 "Scheme for the Identification of Piping Systems", refer to Attachment “B” for abbreviation and label color designations. Letter height shall be a minimum of 1-1/4”. Stencil material shall be fiber board; Stencil paint shall be exterior, gloss, acrylic enamel. The following rectangular duct systems shall be stenciled:

2. Biosafety Cabinet Exhaust.
3. Radioisotope Exhaust.

4. ETO Exhaust.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Heat sealed or heat shrink, spring fasteners, clips or snap-on are acceptable.

E. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

F. All medical gas piping shall have minimum information per NFPA 99, plus operating pressure.

G. Pipe markers and arrow markers also shall be provided for all piping systems.

H. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, up through 6 inch. For piping systems larger than 6 inches, use Seton or Brady strap-on markers or similar by Marking Services, Inc.

2.06 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

A. Description: 3/4” x variable length” vinyl label, 3.0 Mil self-adhesive vinyl similar to Dura Label Pro. Label color shall be black text on a white background. The label shall contain the following information per the template, described in Attachment “C”:

1. Asset Short Description: As listed in Equipment Matrix.


B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.

C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer’s instructions.

D. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.
3.02 VALVE TAGS

A. Contractor(s) shall provide and install valve tags on all valves installed within this Project, except check valves; valves within fabricated equipment units; faucets; hose connections; needle valves; gauge cocks; HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

B. Existing valve tags shall not be attached to new valves. When removing and/or replacing existing tagged valves, give the Owner all existing tags that are attached to the valves that are removed. New tags with new asset numbers shall be provided for new valves.

3.03 APPLICATION OF MARKERS AND STENCILS

A. Piping runs throughout the Project including those above lift-out ceilings, under floor and those exposed to view when access doors or access panels are opened shall be identified by means of pipe markers and/or stencils. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements. In addition to pipe markers and/or stencils, arrow markers shall be used to indicate direction of flow.

B. As a minimum, locate pipe markers and/or stencils as follows:

1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.

2. Every 20 feet in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.

3. At each branch or riser take off on piping systems, excluding short takeoffs for fixtures and terminal units.

4. Provide a pipe marker or stencil and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.

5. At access doors, manholes and similar access points that permit view of concealed piping.

6. Near major equipment items and other points of origination and termination.

C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

D. Provide a double-ended arrow marker when flow can be in either or both directions.

E. Indicate delivered water temperature on domestic hot water supply and return lines.

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

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

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

I. Tag automatic controls, instruments and relays. Key to control schematic.
J. Provide ceiling grid tags to locate valves, fan coil units, dampers or other concealed equipment above T-bar type panel ceilings. Locate in corner of grid closest to equipment.

K. Identify pipe utilizing copper press fittings with markers stating, “Press-Fit” adjacent to each content identification marker.

L. Identify medium pressure gas piping (14 inches water column to 5psi) with the statement, “WARNING – ½ to 5psi NATURAL GAS”.

M. Identify right and left nipple and coupling union assemblies with the statement “Right/Left Nipple/Coupling”.

ATTACHMENTS:

“A” - Label Abbreviations, Background and Text colors
“B” – Label examples with dimensions, font type and height
“C” – Valve tag naming convention

END OF SECTION 20 05 53
<table>
<thead>
<tr>
<th>Pipe Contents</th>
<th>Label Abbreviation</th>
<th>Label Colors (Background/Text)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Waste</td>
<td>ACID</td>
<td>Orange/Black</td>
</tr>
<tr>
<td>Argon</td>
<td>AR</td>
<td>Green/White</td>
</tr>
<tr>
<td>Biosafety Cabinet Exhaust</td>
<td>BCE</td>
<td>Purple/White</td>
</tr>
<tr>
<td>Brine Water</td>
<td>BR</td>
<td>Orange/Black</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>CO₂</td>
<td>Gray/White</td>
</tr>
<tr>
<td>Chemical Fume Hood Exhaust</td>
<td>CFHE</td>
<td>Purple/White</td>
</tr>
<tr>
<td>Chilled Water Return</td>
<td>CHWR</td>
<td>Green/White</td>
</tr>
<tr>
<td>Chilled Water Supply</td>
<td>CHWS</td>
<td>Green/White</td>
</tr>
<tr>
<td>Condensate Drain</td>
<td>CD</td>
<td>Green/White</td>
</tr>
<tr>
<td>Condenser Water Return</td>
<td>CWR</td>
<td>Green/White</td>
</tr>
<tr>
<td>Condenser Water Supply</td>
<td>CWS</td>
<td>Green/White</td>
</tr>
<tr>
<td>Deionized Water Supply</td>
<td>DIS</td>
<td>Green/White</td>
</tr>
<tr>
<td>Deionized Water Return</td>
<td>DIR</td>
<td>Green/White</td>
</tr>
<tr>
<td>ETO Exhaust</td>
<td>ETOE</td>
<td>Purple/white</td>
</tr>
<tr>
<td>Fire Suppression Water</td>
<td>FIRE</td>
<td>Red/White</td>
</tr>
<tr>
<td>Fuel Oil Return</td>
<td>FOR</td>
<td>Yellow/Black</td>
</tr>
<tr>
<td>Fuel Oil Supply</td>
<td>FOS</td>
<td>Yellow/Black</td>
</tr>
<tr>
<td>Gray Water</td>
<td>Gray Water</td>
<td>Gray/White</td>
</tr>
<tr>
<td>Grease Waste (Kitchen)</td>
<td>GW</td>
<td>Black/White</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>HAZ</td>
<td>Orange/Black</td>
</tr>
<tr>
<td>Helium</td>
<td>He</td>
<td>Brown/white</td>
</tr>
<tr>
<td>High Pressure Condensate</td>
<td>HPC</td>
<td>Blue/White</td>
</tr>
<tr>
<td>High Pressure Steam (above 125#)</td>
<td>HPS</td>
<td>Blue/White</td>
</tr>
<tr>
<td>Hot Water Heating Return</td>
<td>HWR</td>
<td>Green/White</td>
</tr>
<tr>
<td>Hot Water Heating Supply</td>
<td>HWS</td>
<td>Green/White</td>
</tr>
<tr>
<td>Instrument Air</td>
<td>IA</td>
<td>Red/white</td>
</tr>
<tr>
<td>Laboratory Compressed Air</td>
<td>Lab Air</td>
<td>Yellow and white checkerboard/black boxed</td>
</tr>
<tr>
<td>Laboratory Vacuum</td>
<td>Lab Vac</td>
<td>White and black checkerboard/black boxed</td>
</tr>
<tr>
<td>Laboratory Waste</td>
<td>Lab Waste</td>
<td>Orange/Black</td>
</tr>
<tr>
<td>Laboratory Vent</td>
<td>Lab Vent</td>
<td>Orange/Black</td>
</tr>
<tr>
<td>Low Pressure Condensate</td>
<td>LPC</td>
<td>Blue/White</td>
</tr>
<tr>
<td>Low Pressure Steam (below 25#)</td>
<td>LPS</td>
<td>Blue/White</td>
</tr>
<tr>
<td>Medical Compressed Air</td>
<td>Med Air</td>
<td>Yellow/black</td>
</tr>
<tr>
<td>Medical–Surgical Vacuum</td>
<td>Med Vac</td>
<td>White/black</td>
</tr>
<tr>
<td>Medium Pressure Condensate</td>
<td>MPC</td>
<td>Blue/White</td>
</tr>
<tr>
<td>Medium Pressure Steam (above 25# - below 125#)</td>
<td>MPS</td>
<td>Blue/White</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>NG</td>
<td>Yellow/Black</td>
</tr>
<tr>
<td>Nitrogen (gaseous)</td>
<td>N₂</td>
<td>Black/white</td>
</tr>
<tr>
<td>Nitrogen (liquid)</td>
<td>LN₂</td>
<td>Black/White</td>
</tr>
<tr>
<td>Nitrous Oxide</td>
<td>N₂O</td>
<td>Blue/white</td>
</tr>
<tr>
<td>Pipe Contents</td>
<td>Label Abbreviation</td>
<td>Label Colors (Background/Text)</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Non-Potable Water</td>
<td></td>
<td>Green/White</td>
</tr>
<tr>
<td>Medical Oxygen</td>
<td>O₂</td>
<td>Green/white</td>
</tr>
<tr>
<td>Potable Cold Water</td>
<td>DCW</td>
<td>Green/white</td>
</tr>
<tr>
<td>Potable Hot Water Return</td>
<td>DHWR</td>
<td>Green/white</td>
</tr>
<tr>
<td>Potable Hot Water Supply</td>
<td>DHW</td>
<td>Green/white</td>
</tr>
<tr>
<td>Pumped Condensate Return</td>
<td>PCR</td>
<td>Blue/White</td>
</tr>
<tr>
<td>Quench Vent</td>
<td></td>
<td>White/Fluorescent Orange</td>
</tr>
<tr>
<td>Radioisotope Exhaust</td>
<td>RE</td>
<td>Yellow/magenta</td>
</tr>
<tr>
<td>Refrigerant Liquid Line (Circuit #1, 2, 3, etc. as applicable)</td>
<td>Refrig Liq #</td>
<td>Green/White</td>
</tr>
<tr>
<td>Refrigerant Suction Line (Circuit #1, 2, 3, etc. as applicable)</td>
<td>Refrig Suct #</td>
<td>Green/White</td>
</tr>
<tr>
<td>Reverse Osmosis Water Supply</td>
<td>ROS</td>
<td>Green/white</td>
</tr>
<tr>
<td>Reverse Osmosis Water Return</td>
<td>ROR</td>
<td>Green/white</td>
</tr>
<tr>
<td>Sanitary Waste</td>
<td>SS</td>
<td>Green/white</td>
</tr>
<tr>
<td>Sanitary Vent</td>
<td>SV</td>
<td>Green/white</td>
</tr>
<tr>
<td>Storm Drain</td>
<td>SD</td>
<td>Green/white</td>
</tr>
<tr>
<td>Softened Water</td>
<td>SW</td>
<td>Green/white</td>
</tr>
<tr>
<td>Waste Anesthetic Gas Disposal</td>
<td>WAGD</td>
<td>Violet/white</td>
</tr>
</tbody>
</table>
**Equipment Tag Layout**

<table>
<thead>
<tr>
<th>Standard Information</th>
<th>FACILITIES MANAGEMENT TAG</th>
<th>FACILITIES MANAGEMENT TAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Short Description (If required, text wrap)</td>
<td><strong>Fan Coil Unit, FCU 13-4</strong></td>
<td><strong>Fan Coil Unit, FCU 13-4</strong></td>
</tr>
<tr>
<td>Asset Number</td>
<td></td>
<td><strong>12260</strong></td>
</tr>
<tr>
<td>Asset Location</td>
<td><strong>Asset Location: G15.3531</strong></td>
<td></td>
</tr>
<tr>
<td>Asset Bar Code Number</td>
<td></td>
<td><strong>BC C39 3 to 1Medium 3 lines for future text</strong></td>
</tr>
<tr>
<td>Standard Information</td>
<td></td>
<td><strong>This is not an Institutional Tag</strong></td>
</tr>
</tbody>
</table>

**Example of Completed Equipment Tag**

<table>
<thead>
<tr>
<th>FACILITIES MANAGEMENT TAG</th>
<th><strong>Fan Coil Unit, FCU 13-4</strong></th>
<th><strong>12260</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Location: G15.3531</td>
<td><strong>Asset Location: G15.3531</strong></td>
<td><strong>This is not an Institutional Tag</strong></td>
</tr>
</tbody>
</table>

The University of Texas
MD Anderson Cancer Center
MS080415

PIPING AND EQUIPMENT IDENTIFICATION – ATTACHMENT “B”
20 05 53
9 of 11
Ceiling Grid Tag Layout for Equipment Located Above Finish Ceiling

<table>
<thead>
<tr>
<th>Tag Information</th>
<th>Asset Bar Code #</th>
<th>Equipment Plan Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾”h x variable length TAG</td>
<td>12260</td>
<td>Fan Coil Unit, FCU 13-4</td>
</tr>
</tbody>
</table>

| Font & Height         | BC C39 3 to 1 Medium | Arial 24                   |
Valve Tag Naming Convention

- The first set of characters are system type designators. (Number of letters will vary per system type)

```
X X X X X - X X X X - X X X
```

System Type Abbreviation (See Attachment “B” for abbreviations)

- A dash shall separate each set of characters.

```
X X X X X X - X X X X - X X X
```

Placeholder

- The middle set of characters are the building designator.

```
X X X X X X - X X X X X - X X X
```

Building Designator (Contact Owner’s Project Manager for building number)

- A dash shall separate each set of characters.

```
X X X X X X X - X X X X X - X X X
```

Placeholder

- The last set of characters are sequential valve tag numbers.

```
X X X X X X - X X X X X - X X X
```

Sequential Valve Tag Number

(Number of digits will vary based on quantity of valves installed)

Below is an Example for a Chilled Water Supply Valve Located in Anderson Central:

```
C H W S - 1 0 0 B - 9
```

NOTE: No two valve tags shall have the same name or asset number. Obtain valve tag names from Owner’s Property Manager when installing valves within existing systems.
SECTION 20 07 19 – PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install piping insulation, jackets and accessories indicated by the Contract Documents with supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.


5. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.


8. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.


10. ASTM C552 - Cellular Glass Thermal Insulation.

12. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).


15. ASTM C921 - Jackets for Thermal Insulation.

16. ASTM C1126 - Faced or Unfaced Rigid Celluar Phenolic Thermal Insulation.


21. ASTM C795 - Insulation For Use Over Austenitic Steel.


1.04 DEFINITIONS

A. Concealed: Areas that cannot be seen by the building occupants.

B. Interior Exposed: Areas that are exposed to view by the building occupants, including equipment rooms.

C. Interior: Areas inside the building exterior envelope that are not exposed to the outdoors.

D. Exterior: Areas outside the building exterior envelope that are exposed to the outdoors, including building crawl spaces and loading dock areas.

1.05 QUALITY ASSURANCE

A. All piping requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.
B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement.

1. Certificates to this effect shall be submitted along with Contractor’s submittal data for this Section of the Specifications.

2. No material shall be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application Company Qualifications: Company performing the Work of this Section shall have minimum three (3) years experience specializing in the trade.

D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.

E. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable.

1.06 SUBMITTALS

A. Product Data:

1. Provide product description, list of materials, “k” value, “R” value, mean temperature range, and thickness for each service and location.

2. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type

B. Operation and Maintenance Data:

1. Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the Project Site in original factory packaging, labeled with manufacturer’s identification including product thermal ratings and thickness.

B. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.
PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Insulation:

1. Owens-Corning (Type P1).
2. Certainteed Corporation (Type P1).
3. Johns Manville Corporation (Type P1).
4. Knauf Corporation (Type P1).
5. Dow Chemical Company (Type P2).
6. Armstrong/Armacell (Armaflex) (Type P3).
7. RBX Industries/Rubatex (Type P3).
8. Industrial Insulation Group, LLC (Type P4).
9. Resolco International by (Insul-Phen) (Type P5).
10. KingSpan Tarec (Kooltherm 37-60) (Type P5C and P5D).
11. FOAMGLAS (Cellular Glass) by Pittsburgh Corning (Type P6).

B. Jackets:

1. Childers Products Company
2. PABCO
3. RPR Products, Inc.
4. Venture Clad Corporation
5. Foster Vapor Fas 62-05
6. Foamglas

C. Coatings, Sealants, and Adhesives:

1. Foster
2. Childers
2.03 INSULATION

A. Type P1: Fiberglass preformed insulation; ASTM C 547; minimum 3.0 lb/cu ft density, ASTM C335, 'k' value of 0.23 at 75 degrees F; noncombustible.

B. Type P2: Molded closed cell polyisocyanurate insulation; ASTM E96, maximum water vapor transmission rating of 0.005 Perm-In; ASTM C518, 'k' value of 0.20 at 75 degrees F; ASTM D2842, water absorption value of 0.05 lb/ft2.

C. Type P3: Closed cell elastomeric, flexible, insulation; ASTM E96; maximum vapor transmission rating of 0.20 perms; ASTM C 518; 'k' value of 0.27 at 75 degrees F.

D. Type P4: Mineral Wool; ASTM C 547; preformed, high temperature insulation; 'k' value of 0.35 at 300 degrees F.

E. Type P5: Phenolic closed cell, ASTM C1126 rigid foam, 2.2 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.13 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).

F. Type P5A: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.02 Perm-In; ASTM C1126 rigid foam, 3.75 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.16 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).

G. Type P5B: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.02 Perm-In; ASTM C1126 rigid foam, 5.0 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.21 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).

H. Type P5C: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.01 Perm-In; ASTM C1126 rigid foam, 2.3 lbs/cu.ft. nominal density, CFC free; ASTM C518, 'k' value of .146 Btu·in/hr·ft2·°F at 77 degrees F.

I. Type P5D: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.01 Perm-In; ASTM C1126 rigid foam, 3.75 lbs/cu.ft. nominal density, CFC free; ASTM C518, 'k' value of .20 Btu·in/hr·ft2·°F at 77 degrees F.

J. Type P6: Cellular Glass, ASTM C552, 7.5 lbs./cu.ft. density, ASTM E96 (Wet Cup Method) 0.00 water vapor perm, ASTM C518 ‘k’ value of 0.29 at 75 degrees F.

2.04 JACKETS

A. Factory Applied Jackets:

1. White kraft bonded to reinforced foil vapor barrier with self-sealing adhesive joints.

2. ASJ White, triple-ply laminate polypropylene, mold resistant, metalized polyester vapor barrier film backing: Venture 1555U or Insulrap 30 Vapor Barrier I-30.

B. Field Applied Jackets:
1. PVC Jackets: UL listed 25/50 rated per ASTM E 84, UV resistant, minimum insulation thickness 0.020 inches for pipe outside diameters up to 18 inches and 0.030 inches for pipe outside diameters 18 inches and above. Standard manufactured PVC cover fittings cover system consisting of one-piece, pre-molded, PVC covers with fiberglass inserts manufactured from 20-mils thick, high-impact, ultraviolet-resistant. Use ultraviolet resistant adhesive as recommended by the manufacturer.

2. Reinforcing Mesh: Glass Fiber Childers Chil-Glas #10 or synthetic 9X8 mesh with minimum weight of 0.9 ounces per square yard.

3. Aluminum Jackets: ASTM B 209; 0.020 inch thick; smooth finish with factory applied moisture barrier.

4. Stainless Steel Jackets: Type 304 stainless steel; 0.010 inch thick; smooth finish.

5. VentureClad 1577CW or Foster Vapor Fas 62-05, zero permeability and mold resistant jacket material, 5-ply laminate with 5-6 mil film with adhesive on one side. Jacketing laminated film must have UV coating for additional exterior protection. Product shall be used with phenolic closed cell insulation where Type 5A and 5B insulation is installed on existing chilled water piping being repaired or being modified.

2.05 COATINGS, SEALANTS, AND ADHESIVES

A. Insulating Cement: ASTM C 195; hydraulic setting mineral wool; Ryder One-Coat.

B. Sealants: Foster 95-50; Childers CP-70 or CP-76
   1. Apply at valves, fittings and where insulation is terminated. Brush-apply sealant to end of insulation and continue along pipe surface.
   2. Below-ambient closed cell pipe insulation (Type P5, P5A, P5B): apply sealant on all longitudinal and butt insulation joints to prevent moisture transmission.

C. Adhesives: Use to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP-82 or Foster 85-20/85-60 as general purpose adhesive. For use with calcium silicate or expanded perlite insulation, use Childers CP-97 or Foster 81-27 fibrous adhesive when adhering pipe saddles and shields to the insulation.

D. Primers: For proper bonding with lagging adhesive/canvas provide light coat of Childers CP-50 AMV1 or Foster 30-36 diluted 50 percent with water over insulation or Pittcoat 300 primer thinned with mineral spirits to cover insulating cements prior to finish coating.

E. Coatings and Mastics:
   1. Vapor barrier coating for indoor, below-ambient applications: Foster 30-80 or Childers CP-38 on all elbows, fittings, and valves. Coating shall adhere to MIL-C-19565C, Type II and shall be QPL listed.
   2. Weather barrier/breather mastics for above-ambient piping applications: Childers CP-10/CP-11 or Foster 46-50.
3. High humidity applications: Foster 30-80 AF or Childers CP-137 AF fungus/mold resistant coating that meets ASTM D 5590 with zero growth rating.

4. Exterior applications: Childers CP 30LO (must be covered by metal jacketing), Childers CP-45 Encace V, or Foster 60-95 Monolar for insulated elbows/fittings, longitudinal seams, and butt joints of vapor barrier jackets or glass cloth jackets.

5. Finish coat over closed cell elastomeric: Foster 30-64 or Armstrong "Finish" acrylic finish.

6. Canvas Finishes:
   a. Apply lagging adhesive to prevent mildew for securing canvas. Apply anti-fungal lagging adhesive that adheres to ASTM D 5590 with zero growth rating. (Foster 30-36AF, Childers CP-137AF) Do not use wheat paste.
   b. Exterior Applications: cover all canvas insulation with a fire-retardant weather barrier mastic. On canvas jacketed systems where seam joints at fittings are rough, cover with an application of insulating cement and smooth with a trowel before the canvas is applied with adhesive. Canvas shall be free of wrinkles and have a smooth, neat appearance.

F. Reinforcing Mesh: Childers Chil-Glas #10 or Foster Mast-a-Fab 9x8 reinforcing mesh with coatings and mastics.

G. Lagging Adhesives/Coatings: Childers CP-50A HV2 or Foster 30-36 for adhering canvas and glass cloths over thermal insulation installed indoors. Adhesive shall adhere to MIL-A-3316C Class I, Grade A.

   a. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating that meets ASTM D 5590 with zero growth rating. Coating shall adhere to MIL-C-19565C, Type II and must be QPL listed.

2.06 APPLICATIONS

A. Interior Concealed Applications (Plenums, Chases):

1. Type P1 Insulation: Provide factory applied ASJ white kraft foil vapor barrier.
   a. Below-ambient piping: Coat all ASJ seams with Foster 30-80 or Childers CP-38 vapor barrier coating. Coat all elbows, fittings, and valves with same vapor barrier coating and Foster Mast-a-Fab or Childers Chil-Glas #10 reinforcing mesh.
   b. High humidity applications: Foster 30-36 AF.

2. Type P3 Insulation: Finish coat is not required.

3. Type P4 Insulation: Lightly coat insulation with lagging adhesive diluted 50% with water for proper bonding with canvas/lagging adhesive. Cover with a canvas jacket and non-diluted Childers CP-50A HV2 or Foster 30-36 lagging adhesive.
   a. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating.
4. Type P5 and P5A, 5B Insulation: VentureClad jacket on piping where condensation can occur or where installed on existing chilled water piping, chilled water condensate drain piping, and roof storm drain piping that transports cold rain water from the building roof.

5. Type P5 Jacket not required when insulation is used on hot water piping.

6. Type P6 Insulation:
   a. Above-ambient piping: Pittcoat 404, Foster 46-50, or Childers CP-10/11 pre-molded PVC covers per manufacturer’s recommendations. Jacket is not required when this type of piping insulation is concealed within a piping chase.
   b. Below-ambient piping: Coat all ASJ seams with Foster 30-80 or Childers CP-38 vapor barrier coating. Coat all elbows, fittings, and valves with same vapor barrier coating and Foster Mast-a-Fab or Childers Chil-Glas #10 reinforcing mesh.
   c. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating.

B. Interior Exposed Applications (Equipment Rooms):

1. Type P1 and P2 Insulation: Factory applied ASJ white kraft foil vapor barrier. Finish with canvas jacket or Childers Chil-Glas #10 glass membrane with Childers CP-50A HV2 or Foster 30-36. Verify jacket is suitable for applications.
   a. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating. Finish coat is not required.

2. Type P3 Insulation: Finish coat is not required.

3. Type P4 Insulation: Lightly coat insulation with lagging adhesive diluted 50% with water for proper bonding with canvas/lagging adhesive. Cover with a canvas jacket and non-diluted Childers CP-50A HV2 or Foster 30-60 lagging adhesive.
   a. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating. Finish coat is not required.

4. Type P5 Insulation: Factory applied ASJ white kraft foil vapor barrier.

5. Type P5 and P5A Insulation: VentureClad jacket on piping where condensation can occur or where installed on existing chilled water piping, chilled water condensate drain piping, and roof storm drain piping that transports cold rain water from the building roof.

6. Type P6 Insulation: Provide triple-ply laminate polypropylene, mold resistant with a metal foil and polyester vapor barrier film backing.
   a. Below-ambient piping: Coat all ASJ seams with Foster 30-80 or Childers CP-38 vapor barrier coating. Coat all elbows, fittings, and valves with same vapor barrier coating and Foster Mast-a-Fab or Childers Chil-Glas #10 reinforcing mesh.
   b. Above-ambient piping: Provide Pittcoat 404, Foster 46-50, or Childers CP-10/11 or pre-molded PVC covers per manufacturer’s recommendations.
c. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating.

7. All exposed insulated piping within six (6) feet of the floor shall be protected with aluminum or stainless steel jacket to protect insulation from being torn or punctured.

C. Exterior Applications:

1. Insulate piping system as indicated under Interior Exposed Applications, prior to final jacket installation.

2. Provide electric heat tracing for all exterior small bore piping 2 inches and smaller where water may be susceptible to freezing due to intermittent flow conditions.

3. Final jacket cover shall be aluminum or stainless steel having integral moisture barrier with seams located at 2 or 10 o’clock position of horizontal piping. All laps shall be minimum 2 inches. Apply Foster 95-44 or Childers CP-76 metal jacketing sealant on all laps to prevent water transmission.

4. Type P1 Insulation: For above-ambient piping, finish with Childers Chil-Glas #10 or 9X8 reinforcing mesh and Childers CP-10/CP-11, or Foster 46-50 weather barrier/breather mastic, prior to final jacket installation.

5. P6 Insulation Above-ground: Provide (50 mil thickness) self-sealing non-metallic, bituminous compound reinforced with glass fiber membrane with 1 mil aluminum top film jacketing for both chilled water and hot water piping (PITTWRAP CW Plus). Provide metal jacketing where material is exposed to ultraviolet rays.


2.07 INSERTS, SUPPORTS AND SHIELDS

A. Application: Piping 1/2 inch diameter or larger for all systems except direct buried.

B. Shields shall be made of galvanized steel or made of black iron painted on both sides with a minimum two coats of aluminum paint. Minimum metal shield sizes shall be as listed within the following table. Provide thicker/longer shields where recommended by insulation manufacturer’s published product installation data:

<table>
<thead>
<tr>
<th>Nominal IPS (inches)</th>
<th>Minimum Metal Thickness (gage)</th>
<th>Minimum Length (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ to 11/4</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>11/2 to 2</td>
<td>16</td>
<td>12</td>
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<tr>
<td>21/2 to 8</td>
<td>14</td>
<td>18</td>
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<tr>
<td>10</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>

C. Provide MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier.
D. Inserts for shields shall be manufactured of 7.5 lb/cu. ft. density cellular glass or 5.0 lb/cu. ft. density cellular, phenolic insulating material suitable for the planned temperature range. Provide factory fabricated inserts with integral galvanized pipe saddles. Inserts shall be the same thickness as the adjacent insulation.

E. Depending on the type of pipe support design, stainless steel bands or aluminum bands may be required to keep shield material next to the jacketing material.

1. Insulation Bands: 3/4 inch wide; 0.007 inch thick galvanized steel when exposed to interior environment, 0.010 inch thick stainless steel or 0.015 inch thick aluminum when exposed to humid interior environment or outside environment.

2. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that piping has been inspected at the welds and pressure tested before applying paint and insulation materials.

B. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping shall be completely dry at the time of application of primer paint. Painting on piping where condensation is occurring on the pipe surface is strictly prohibited.

C. Provide primer coat on all steel piping field welds. Painting shall be completed and approved prior to installation of insulation. Paint shall be applied in accordance with the paint manufacturer’s instructions, environment, and pipe surface temperatures.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Installation of insulation and jacket materials shall be in accordance with manufacturer’s published instructions.

C. Handle and install materials in accordance with manufacturer’s instructions in the absence of specific instructions herein.

D. On exposed piping, locate insulation cover seams with the ridge of the lap joint is directed down.

E. Exposed Insulated piping within six feet of the floor shall be protected with an aluminum or stainless jacket material to protect the insulation.
F. Insulate fittings, joints and valves with molded insulation of the same material and thickness as adjoining pipe. Open voids and cracks insulation shall be kept at a minimum when placing insulation on abnormal or irregular shapes. Use closed cell or recommended fill material as instructed by the insulation manufacturer to close openings. Fiberglass insulation shall not be used as a fill material on chilled water piping or fittings. Vapor seal all cold piping ASJ seams and elbows/fittings with vapor barrier coating and reinforcing mesh.

G. Continue insulation through walls, sleeves, pipe hangers, floors, and other pipe penetrations.

H. Provide dams in insulation at intervals not to exceed 20 feet on cold piping systems to prevent migration of condensation or fluid leaks. Indicate visually where the dams are located for maintenance personnel to identify and also provide dams at butt joints of insulation at fittings, flanges, valves, and hangers.

I. Where insulation is required, insulate entire system including fittings, valves, flanges and strainers. Use closed cell insulation on cold piping system flexible connections, expansion joints and unions, bevel and seal ends of insulation and continue sealant or coating a minimum of 4 inches along the piping, unless stated otherwise. On all closed-cell insulation, cold piping, use insulation joint sealant on all longitudinal and butt joints.

J. For hot piping conveying fluids 180 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation. Continue sealant or coating a minimum of 4 inches along the piping.

K. On heating piping systems conveying fluids over 180 degrees F with unions, flanges, valves, strainers and equipment that are anticipated to be removed for maintenance, the insulation shall terminate (beveled to pipe) just prior to the flange or union with vapor barrier sealed to pipe. The tapered segment of insulation shall not interfere with the removal of unions flange bolts or equipment. The unions, flanges, valves and strainers shall be insulated with removable insulated covers with toggle catches or Velcro straps.

L. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3 inches). Where insulation terminates, it shall be neatly beveled and finished. All materials used shall be fire retardant or nonflammable.

M. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed with vapor barrier coating. Where insulation with a vapor barrier terminates, seal off with vapor barrier continuous to the surface being insulated. Ends shall not be left raw.

N. Where pipe chases are tight, adequate provision shall be made at the rough-in stage using offset fittings or other means (except springing the pipe) to ensure that insulation can be applied throughout the length of the pipe.

O. When installing phenolic insulation provide a 5 lb. density insert of same thickness and contour as adjoining 3.75 lb. density insulation, between the support shield and piping, and under the finish jacket, on piping 1½ inch diameter or larger, to prevent insulation from sagging at support points. Provide inserts for 180-degree arc and not less than 2 inches more than the length of the pipe support shield or minimum 12 inches long (whichever is greater). Pipe support shield shall be adhered to insulation with a UL approved adhesive that meets E-84 requirements.
P. Seal all insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.

Q. Shields:

1. Install between pipe hangers or pipe hanger rolls and inserts. Curved metal shields shall be used between the hangers or support points and at the bottom of insulated pipe.

2. Hangers shall support the load of the insulated pipe section on the outside of the insulation and shall not be in direct contact with the pipe.

3. Manufacturer shall be responsible to size the length of shield required to prevent insulation from breaking.

4. Provide rigid insulation at each support point, a minimum of 2 inches longer than shield length.

5. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe.

3.03 EXISTING CHILLED WATER PIPING INSULATED WITH PHENOLIC FOAM INSULATION

A. Re-insulate existing piping systems after repairs have been performed in the same manner as the original installation unless:

1. The nature of damage to the insulation indicates that the system was not insulated properly, and that installation of flashing will be necessary where leaks occur.
   a. Increasing the thickness of the insulation may be required when condensation occurs.
   b. Provide insulation expansion joints where large cracks or gaps occur.

B. Materials:

1. When possible carefully remove existing insulation material so it can be reapplied, and provide temporary protection to adjacent insulation material to prevent damage while repairs are underway.

2. When performing a hot tap, maintenance to a strainer, or adding a mechanical component or similar to an operating chilled water system, apply temporary insulation to prevent moisture damage to exposed insulation material. Qualified insulation subcontractor personnel shall assist in the following:
   a. Strainers; dry the strainer body prior to installing the insulating cap. Ensure that the exposed insulation and insulating cap is dry and free of any contamination. Tape in place then finish with reinforcing mesh and vapor barrier coating.
b. Hot tap: to eliminate the possibility of moisture migration into the existing insulation, remove the complete section of the pipe covering where the operation will occur. Apply duct wrap on the raw ends of the adjacent insulation in both directions at a 12 inch length. Use FSK tape to secure the wrap. After completion of the hot tap, remove the temporary insulation and inspect the protected sections to ensure the sections are dry and free from contaminates. Re-insulate and seal the circumferential and longitudinal joints with Foster 30-45 or Childers CP-70. Apply FSK tape at the seams to match the existing facing system.

c. Use freezing blankets to install new mechanical components to an existing chilled water piping section. Remove enough insulation to install the freezing blankets plus one additional section in either direction. To eliminate the possibility of moisture migration, remove the complete section of the pipe covering where the operation will occur. Apply duct wrap on the raw ends of the adjacent insulation in both directions at a 12 inch length. Use FSK tape to secure the wrap. After completion of the procedure, remove the temporary insulation and inspect the protected sections to ensure that the insulation sections are dry and free from contaminates. Re-insulate and seal the circumferential and longitudinal joints with a Foster 30-45 or Childers CP-70 or equivalent. Apply tape at the seams to match the existing facing system.

C. Maintenance and Inspection Methods:

1. Conduct periodic inspections as determined by the Owner, to address the following:

   a. Replace missing insulation and protect adjacent insulation which can become burned or wet after maintenance has been performed to the system.

   b. Repair leaks or spills and remove and replace damaged insulation.

   c. Repair breaks, tears, cracks, or punctures of the vapor barrier or protective covering. Verify that the existing insulation is dry and if wet replace the entire affected section as described in this section.

   d. On piping exposed to the outdoor environment, replace the affected section of insulation as described in this section and use galvanized steel, aluminum or stainless steel to protect the insulation from being crushed due to foot traffic or maintenance equipment. PVC is appropriate for interior areas not subject to foot traffic.

3.04 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

A. In no case shall installed piping insulation have insulation thicknesses that are less than what is required by local energy codes and ASHRAE 90.1 (whichever is more stringent), based on comparable insulation conductivity values at the specified mean rating temperature.

B. Type 5A and 5B insulation is only used where it is being replaced on existing pipe and thickness of the replacement insulation shall match the existing insulation thickness.

<table>
<thead>
<tr>
<th>Piping Systems</th>
<th>Location</th>
<th>Type</th>
<th>Pipe Size</th>
<th>Insulation Thickness</th>
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</thead>
<tbody>
<tr>
<td>Interior</td>
<td>P1</td>
<td>1-1/2&quot; &amp; Smaller</td>
<td>1/2&quot;</td>
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<tr>
<td>Piping Systems</td>
<td>Location</td>
<td>Type</td>
<td>Pipe Size</td>
<td>Insulation Thickness</td>
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<tr>
<td>Domestic Cold Water, Soft Water, Make-Up Water</td>
<td>Concealed</td>
<td>P5</td>
<td>2&quot; to 4&quot;</td>
<td>1/2&quot;</td>
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<td>(NOTE: Insulation is not required where piping is</td>
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<td>6&quot; &amp; Larger</td>
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<td>exposed within equipment rooms.)</td>
<td>Interior Exposed</td>
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<td>Interior Exposed</td>
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<td>Domestic Cold Water, Soft Water, Make-Up Water</td>
<td>Exterior</td>
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<td>4&quot; &amp; Smaller</td>
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<td>6&quot; &amp; Larger</td>
<td>1-1/2&quot;</td>
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<td>Domestic Hot Water, Tempered Water (Maximum 200</td>
<td>Interior</td>
<td>P1</td>
<td>2&quot; &amp; Smaller</td>
<td>1&quot;</td>
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<td>Degrees F)</td>
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<td>2-1/2&quot; &amp; Larger</td>
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<td></td>
<td>Interior</td>
<td>P5</td>
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<td>3/4&quot;</td>
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<td>Exposed</td>
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<td>6&quot; &amp; Larger</td>
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<td>Exterior</td>
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<td>All Sizes</td>
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<td>All Sizes</td>
<td>1-1/2&quot;</td>
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<td>Fire Protection Water (40 Degrees F – Nominal)</td>
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<td>P5</td>
<td>4&quot; and Smaller</td>
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<td>6&quot; and Larger</td>
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<td>Underside of all Roof / Overflow Drain Bodies and</td>
<td>Interior</td>
<td>P5</td>
<td>2&quot; to 4&quot;</td>
<td>3/4&quot;</td>
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<td>related horizontal roof drain lines to vertical</td>
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<td>P6</td>
<td>6&quot; and Larger</td>
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<td>6&quot; and Larger</td>
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<td>Interior</td>
<td>P1</td>
<td>2&quot; to 4&quot;</td>
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<td>Concealed</td>
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<td>Exposed</td>
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<td>6&quot; and Larger</td>
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<td></td>
<td>Interior</td>
<td>P1</td>
<td>2&quot; to 4&quot;</td>
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<td></td>
<td>Concealed</td>
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<td>6&quot; and Larger</td>
<td>1/2&quot;</td>
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<tr>
<td>Cold Condensate Drain Lines</td>
<td>Interior</td>
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<td>All Sizes</td>
<td>3/4&quot;</td>
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<td>4&quot; and Smaller</td>
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<td>6&quot; &amp; Larger</td>
<td>1-1/2&quot;</td>
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<tr>
<td>Piping Systems</td>
<td>Location</td>
<td>Type</td>
<td>Pipe Size</td>
<td>Insulation Thickness</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
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</tr>
<tr>
<td>Building Heating Hot Water (Maximum 160 Degrees F)</td>
<td>Interior Concealed</td>
<td>P3</td>
<td>All Sizes</td>
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<td></td>
<td>P6</td>
<td>All Sizes</td>
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<td></td>
<td>Interior Exposed</td>
<td>P5</td>
<td>2-1/2” and Smaller</td>
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<td>Interior Concealed</td>
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<td>3” and Larger</td>
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<td>Interior Exposed</td>
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<td>Interior Concealed</td>
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<td>2-1/2” and Smaller</td>
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<td></td>
<td>3” and Larger</td>
<td>1-1/2”</td>
</tr>
<tr>
<td></td>
<td>Exterior</td>
<td>P2</td>
<td>2-1/2” and Smaller</td>
<td>1”</td>
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<td></td>
<td>3” and Larger</td>
<td>1-1/2”</td>
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<td></td>
<td>Exterior</td>
<td>P5</td>
<td>2-1/2” and Smaller</td>
<td>1-1/2”</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>3” and Larger</td>
<td>2”</td>
</tr>
<tr>
<td>Chilled Water (Includes Process Chilled Water)</td>
<td>Interior</td>
<td>P6</td>
<td>4” and Smaller</td>
<td>1-1/2”</td>
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<td></td>
<td>6” and Larger</td>
<td>2”</td>
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<tr>
<td></td>
<td>Exterior</td>
<td>P6</td>
<td>4” and Smaller</td>
<td>2”</td>
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<td></td>
<td></td>
<td></td>
<td>6” and Larger</td>
<td>3-1/2”</td>
</tr>
<tr>
<td>Low Pressure Steam, Boiler Feedwater, Steam Condensate Return, Compresses Air Discharge, Boiler Blowdown (201 Degrees F to 250 Degrees F)</td>
<td>All</td>
<td>P1</td>
<td>2-1/2” and Smaller</td>
<td>2”</td>
</tr>
<tr>
<td></td>
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<td>3” to 6”</td>
<td>3”</td>
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<td></td>
<td>8” and Larger</td>
<td>3-1/2”</td>
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<td>Less than 1-1/2”</td>
<td>1-1/2”</td>
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<td></td>
<td></td>
<td></td>
<td>1-1/2” &amp; Larger</td>
<td>2”</td>
</tr>
<tr>
<td>Medium Temp. Hot Water and Steam (251 Degrees F to 350 Degrees F)</td>
<td>All</td>
<td>P4</td>
<td>Less than 1”</td>
<td>1-1/2”</td>
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<td>1” to 1-1/2”</td>
<td>2-1/2”</td>
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<td></td>
<td></td>
<td></td>
<td>1-1/2” and Larger</td>
<td>3”</td>
</tr>
<tr>
<td>High Temp. Hot Water (351 Degrees F to 400 Degrees F) and Steam (351 Degrees F to 600 Degrees F)</td>
<td>All</td>
<td>P4</td>
<td>Less than 1”</td>
<td>2-1/2”</td>
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<tr>
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<td>1” to 4”</td>
<td>3”</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>4” and Larger</td>
<td>4”</td>
</tr>
</tbody>
</table>

END OF SECTION 20 07 19
SECTION 20 08 00 – FIRE SUPPRESSION/PLUMBING/HVAC SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. The purpose of this Section is to define responsibilities in the Commissioning process. Additional system testing is required within individual Specification Sections.

B. Ensure that all systems are operating in a manner consistent with the Contract Documents. General Commissioning requirements and coordination are detailed in Division 01. Execute all Commissioning responsibilities assigned and include the cost of Commissioning in the Contract price.

C. HVAC systems to be commissioned include the following

   1. Air Handling Units
   2. Fans
   3. Piping Systems
   4. Ductwork Systems
   5. Fire, Fire/Smoke and Volume Dampers
   6. Terminal Units
   7. Building Automation System

D. Plumbing Systems to be commissioned include the following:

   1. Sanitary Waste and Vent
   2. Laboratory (Chemical) Waste and Vent
   3. Domestic Cold Water Distribution
   4. Laboratory Compressed Gas Manifolds
   5. Medical Gas and Vacuum System Alarms
   6. Laboratory Gas and Vacuum System Alarms
7. Medical Gas and Vacuum Distribution
8. Laboratory Gas and Vacuum Distribution
9. Plumbing Fixtures

E. Fire Protection Systems to be commissioned include the following:
   1. Wet Fire Sprinkler
   2. Fire Protection Systems/Emergency Power Source Integration
   3. Fire Protection Systems/Fire Alarm System Integration

1.03 REFERENCE STANDARDS
A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 DEFINITIONS
A. Refer to Specification Section 01 91 00 – General Commissioning Requirements for definitions.

1.05 SUBMITTALS
A. Contractor shall prepare Prefunctional Checklists and Functional Performance Test (FPT) procedures and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Owner for review and approval.
B. Contractor shall provide Owner with documentation required for Commissioning Work. At minimum, documentation shall include: Detailed Start-up procedures, full sequences of operation, Operating and Maintenance data, performance data, Functional Performance Test Procedures, control drawings, and details of Owner-contracted tests.
C. Contractor shall submit to Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.
D. Contractor shall review and approve other relative documentation for impact on FPT’s of the systems:
1. Shop drawings and product submittal data related to systems or equipment to be commissioned. The Subcontractor responsible for the FPT shall review and incorporate comments from the Owner and A/E via the Contractor.

2. Incorporate manufacturer’s Start-up procedures with Prefunctional checklists.

3. Draft Test, Adjust and Balance (TAB) Reports: Review and provide comments to Owner.

4. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT’s.

5. Completed equipment Start-up certification forms along with the manufacturer’s field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT’s. Owner may require that system one-line diagrams and applicable Specification Section(s) be attached to the FPT documentation.

6. Final TAB Reports: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT’s.

7. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

**PART 2 - PRODUCTS**

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 TEST EQUIPMENT

A. Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

B. Refer to Specification Section 01 91 00 – General Commissioning Requirements.

**PART 3 - EXECUTION**

3.01 PREPARATION

A. Construction Phase:

1. In each purchase order or subcontract that is written for changes in scope, include the following requirements for submittal data, Commissioning documentation, testing assistance, Operating and Maintenance (O&M) data, and training, as a minimum.
2. Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings scheduled by the Contractor to facilitate the Commissioning process.

3. Provide manufacturer’s data sheets and shop drawing submittals of equipment.

4. Provide additional requested documentation to the Contractor, prior to O&M manual submittals, for development of Prefunctional Checklist and Functional Performance Tests procedures.
   a. Typically, this will include detailed manufacturer’s installation and Start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.
   b. In addition, the installation, Start-up, and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Contractor.
   c. This information and data request may be made prior to normal submittals.

5. With input from the BAS Provider and A/E, Clarify the operation and control of commissioned equipment in areas where the Specifications, BAS control drawings, or equipment documentation are not sufficient for writing detailed test procedures.

6. Prepare the specific Functional Performance Test procedures specified in Section 20 08 16. Ensure that Functional Performance Test procedures address feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests.

7. Develop the Commissioning Plan using manufacturer’s Start-up procedures and the Prefunctional Checklists. Submit manufacturer’s detailed Start-up procedures and the Commissioning Plan and procedures and other requested equipment documentation to Owner for review.

8. During the Start-up and initial checkout process, execute and document related portions of the Prefunctional Checklists for all commissioned equipment.

9. Perform and clearly document all completed Prefunctional Checklists and Start-up procedures. Provide a copy to the Owner prior to the Functional Performance Test.

10. Address current A/E and Owner punch list items before Functional Performance Tests. Air and water test, adjust and balance shall be completed with discrepancies and problems remedied before Functional Performance Tests of the respective air or water related systems are executed.

11. Provide skilled technicians to execute starting of equipment and to assist in execution of Functional Performance Tests. Ensure that they are available and present during the agreed-upon schedules and for a sufficient duration to complete the necessary tests, adjustments, and problem solving.
12. Correct deficiencies (differences between specified and observed performance) as interpreted by the Owner’s Project Manager and A/E and retest the system and equipment.

13. Compile all Commissioning records and documentation to be included in a Commissioning and Closeout Manual.

14. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to actual conditions.

15. During construction, maintain Record Drawings and Specifications of all Contract Documents and Contractor-generated coordination Drawings. Update after completion of Commissioning activities (include deferred tests). The Record Drawings and Specifications shall be delivered to the Owner both in electronic format as required by the Owner.

16. Provide training of the Owner’s operating personnel as specified.

17. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

B. Warranty Phase:

1. Execute seasonal or deferred tests, witnessed by the Owner, according to the Specifications.
   
   a. Complete deferred tests as part of this Contract during the Warranty Period. Schedule this activity with Owner. Perform tests and document and correct deficiencies. Owner may observe the tests and review and approve test documentation and deficiency corrections.
   
   b. If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, execution of such test may be delayed to later in the Warranty Period, upon approval of the Owner. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as deferred tests.

2. Correct deficiencies and make necessary adjustments to O&M manuals, Commissioning documentation, and Record Drawings for applicable issues identified in any seasonal testing.

3.02 TESTING

A. Prefunctional Checklists and Start-up:

1. Follow the Start-up and initial checkout procedures listed in this Section and in Division 01. Start-up and complete systems and sub-systems so they are fully functional, meeting the requirements of the Contract Documents.

2. Prefunctional Checklists shall be complete prior to commencement of a Functional Performance test.
B. Functional Performance Tests:

1. Functional Performance Tests are conducted after system Start-up and checkout is satisfactorily completed. Air balancing and water balancing shall be completed before Functional Performance Tests.

C. Coordination Between Testing Parties:

1. Factory Start-ups: Factory Start-ups are specified for certain equipment. Factory Start-ups generally are Start-up related activities that will be reviewed and checked prior to Functional Performance Tests. All costs associated with factory Start-ups shall be included with the contract price unless otherwise noted. Notify the Commissioning Team of the factory Start-up schedule and coordinate these factory Start-ups with witnessing parties. The Commissioning Team members may witness these Start-ups at their discretion.

2. Independent Testing Agencies: For systems that specify testing by an independent testing agency, the cost of the test shall be included in the Contract price unless otherwise noted. Testing performed by independent agencies may cover aspects required in the Prefunctional Checklists, Start-ups, and Functional Performance Tests. Coordinate with the independent testing agency so that Owner and/or A/E can witness the test to ensure that applicable aspects of the test meet requirements.

3.03 TRAINING

A. Refer Specification Section 01 79 00 – Demonstration and Training.

END OF SECTION 20 08 00
SECTION 20 08 13 – FIRE SUPPRESSION/PLUMBING/HVAC SYSTEMS PREFUNCTIONAL CHECKLIST AND START-UPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section expands on and defines responsibilities of the Contractor regarding Prefunctional Checklists and Start-up portions of the Commissioning process and addresses validation of proper and thorough installation of mechanical, plumbing and fire protection systems.

B. Contractor shall oversee the Commissioning activities with the Contractor’s Subcontractors and the Architect/Engineer (A/E).

C. Contractor shall completely install, thoroughly inspect, Start-up, test, adjust and integrate air and water balance by Owner’s TAB firm on systems and equipment. All activities shall be documented on specific, procedural forms developed for that purpose. Contractor shall notify A/E and Owner in writing that systems are complete and ready for verification and Functional Performance Tests.

D. Completed Prefunctional Checklists for all pieces of equipment shall be submitted to the Owner prior to Functional Performance Tests.

E. Responsibilities of the various parties involved in the Commissioning process are defined in Section 20 08 00.

F. Refer to Attachments A, B, and C at the end of this Section for example forms that indicate level of documentation required for the Commissioning process.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.
1.04 SUBMITTALS

A. Prefunctional Checklists, Prefunctional Tests, and Start-up documents are the normal procedure of ensuring that the mechanical, plumbing, and fire protection system components are properly installed.

B. The Subcontractor in cooperation with the A/E and Contractor shall develop Prefunctional Checklists and Prefunctional Tests during the Construction Phase.

C. Completeness of Prefunctional Checklists: This Section summarizes the minimum standard for systems and equipment checkout. A record of testing and acknowledgement that a procedure has been completed and that it checks out acceptably must be included in the Prefunctional Checklists. The Prefunctional Checklist shall identify in columnar format each device, location, test method, control sequence of operation reference, device code reported, and other data as appropriate.

D. Equipment Data Documentation: Provide completed, as-installed, specific product nameplate data, product numbers, serial numbers, etc. to fully define the asset for Owner's use in maintenance management and asset tracking. This data may be incorporated within the Equipment Matrix as described in Division 01 as a spreadsheet format or electronic database. In addition to specific manufacturer's name and specific product identifiers such as model number, serial numbers, date of manufacture, etc, the following information shall be included with the equipment data documentation:

1. Capacity data: Where applicable, use equipment schedules on the Drawings as a guideline for fields to be used.

2. Location identifier field for each of the three dimensions (Floor Level, X axis, and Y axis) using the Drawing column grids as the basis for location.

E. Submit the equipment data documentation with the draft Prefunctional Checklists to the Owner for approval. A/E and Owner will review the Prefunctional Checklists and request any additional information required to meet the Commissioning Plan criteria.

F. Written Certification: The Contractor shall certify that the installation, Start-up, Prefunctional Checklist, and initial operation of the system or component is in accordance with the Contract Documents, Commissioning Plan, and manufacturer's requirements, and that the system is ready for Functional Performance Tests. Any outstanding items or non-conformance shall be clearly indicated and highlighted on the Prefunctional Checklist and an action item shall have been initiated. Refer to Division 01 for specific details on non-conformance issues relating to Prefunctional Checklists.

G. Refer to Section 20 08 00 for additional documentation requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
B. The Prefunctional Checklist procedures described in this Section provide minimum guidelines for development of Prefunctional Checklists; Start-up procedures, and Prefunctional Tests. Contractor shall prepare the Prefunctional Checklists using these procedures and that of the manufacturers and/or applicable codes and standards.

C. The Prefunctional Checklist form shall acknowledge that installation and Start-up procedures were successfully adhered to and completely performed and shall document relevant parameters (panel and equipment connections, measured values, ground faults, trip settings, etc.). When indicated as performing a checkout on multiple items or multiple procedure items, Prefunctional Checklist forms shall itemize each individual item.

PART 3 - EXECUTION

3.01 PREFUNCTIONAL CHECKLIST PROCEDURES

A. Valves:
   1. Operate all manual and automatic valves through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
   2. Verify that actuators are properly installed with adequate clearance.
   3. For automatic, pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.

B. Meters and Gauges:
   1. Adjust faces of meters and gauges to proper angle for best visibility.
   2. Clean windows of meters and gauges, including factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gauges that require temporary manual connection of readout device such as pressure taps on a flow measuring device, ensure that threads are clean and that connection can be easily made.
   3. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

C. Mechanical Identification:
   1. Verify that all valve tags, piping, duct, and equipment labeling corresponds with the Drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
   2. Adjusting: Relocate any mechanical identification device which has become visually blocked by Work of this Division or other Divisions.
   3. Cleaning: Clean the face of identification devices and glass frames of valve charts.

D. Mechanical Insulation:
   1. Examine all systems and equipment specified to be insulated.
2. Patch and repair all insulation that has been damaged after installation.

3. Ensure the integrity of the vapor barrier around all cold surfaces.

E. Fire Suppression Systems:

1. Additional procedures required for Testing and inspection of Fire Protection Systems are specified within individual Specification Sections. Testing of fire protection systems will generally be conducted by the Fire Protection Subcontractor with Contractor and Owner witnessing.

   a. Check operation prior to, during, and after a power outage to ensure required sequences and system restart.

2. Fire Protection Subcontractor shall submit forms to the Contractor for approval in concert with the appropriate mechanical system Prefunctional Checklist forms. All procedures and results shall be documented in the approved forms.

F. Piping:

1. The following applies to all installed piping systems including underground Site utilities. Responsibility for preparation of the Prefunctional Checklist and testing of the piping systems generally lies with the installing Subcontractor.

   a. Inspect all piping for proper installation, adequate support with appropriate vibration isolation where applicable, and adequate isolation valves for required service.

   b. Flush and treat all piping as appropriate to the application and clean all strainers.

   c. Ensure that adequate drainage is provided at low points and venting is provided at high points. Ensure that air is thoroughly removed from the system as applicable.

   d. Ensure that all piping is adequately supported and anchored to allow expansion. As applicable, bump across the line pumps and inspect for excessive pipe movement.

   e. Pressure and/or leak test all applicable systems in accordance with requirements in the applicable Specification Sections. Record pressure testing results and certification that piping meets the Specification and submit with the Prefunctional Checklist.

   f. Sterilize applicable piping systems as specified in the individual Specification Sections and as required by regulatory authorities. Record the results of sterilization and all parameters during this process and certify that the piping meets the Specification. Include results with Prefunctional Checklist.

   g. Submit test reports that document testing results and certification of results with the Prefunctional Checklist.

   h. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation. Document setting and actual trip points of all such controls.

   i. Set and adjust fill, pressure, or level controls to the required setting.
j. Compare installation with mark-up Record Drawings to ensure the drawing accuracy.

G. AC Motors:
   1. The following applies to all AC motors serving equipment.
      a. Verify proper alignment, installation, and rotation.
      b. Measure the insulation resistance, phase balance, and resistance to ground. These measurements will generally be the responsibility of the mechanical Subcontractor who is connecting the motor. The motor manufacturer will be responsible to correct any deficiencies. When electrical Subcontractor wires to a single point of a packaged device that is shipped with multiple motors, electrical Subcontractor shall check all motors in the package.
      c. Verify that properly sized overloads are in place.
      d. Measure voltage available to all phases at the time of initial connection and after the motor has been placed in operation under load measure amps and RPM.
      e. Record all motor nameplate data.

H. Hydronic Piping:
   1. Refer to Piping Section.
   2. Prepare hydronic and test piping in accordance with applicable Specification Section and ASME B 31.9 and/or B 31.1.
   3. Flush system with clean water. Clean strainers.
   4. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.
   5. Check expansion tanks to verify that tanks are not air bound and that the system is completely full of water.
   6. Set automatic fill valves for required system pressure.
   7. Check air vents at high points of systems and determine if air vents are installed and operating freely (automatic type) or to bleed air completely (manual type).
   8. Set and coordinate automatic fill pressure and relief valve settings.

I. Steam and Condensate Piping:
   1. Refer to Piping Section.
   2. Prepare and test steam and condensate piping in accordance with applicable Section and ASME B 31.9 and or B31.1 as applicable.
   3. Flush the system with clean water. Remove, clean, and replace strainer screens.
4. Gradually warm-up piping and connected equipment. Introduce steam to piping system by throttling valves.

5. Take precautions to prevent water hammer or slugging in piping.

6. Vent air and non-condensable gases from system.

7. Supervise condensate removal at system traps. Temporarily bypass traps, if required.

8. Verify complete condensate removal from piping and equipment and that traps are functioning properly.

J. Terminal Units:

1. General: After construction and painting is completed, clean exposed surfaces of the terminal unit and vacuum clean terminal coils and inside of cabinets.

2. Retouch any marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

3. Ensure that the unit is properly supported.

4. Verify adequate access for maintenance.

5. Verify that the unit is installed per manufacturer’s instructions and details.

6. Install new filters for terminal units that require filters.

7. Open vents to ensure that the coil is properly vented.

8. Check that the unit is properly labeled and/or a ceiling marker has been provided for concealed terminal units.

9. Check power and control voltages.

10. Check for proper condensate drainage as applicable.

11. Check rotation of fan where applicable.

12. Check calibration and operation of the controlling elements.

13. Check control valves for required close off and fail position.

14. Temporary Closure: Verify terminal units which are not scheduled to operate are provided temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris unit is scheduled to operate.

15. Verify that thermostats or temperature sensors are in a proper location to adequately represent space temperature. Verify temperature sensors not scheduled to be installed are secured properly on the top of the unit.

K. VAV Terminal Units:
1. General: After construction and painting is completed, clean exposed surfaces of terminal units and vacuum clean terminal coils and inside of cabinets.

2. Retouch any marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

3. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.

4. Verify that proper access has been provided to the airflow control devices and any heat exchange surfaces.

5. Ensure that the air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.

6. Check all dampers and linkages and wiring and tubing as applicable for tightness of the connections and terminations.

7. Refer to associated zone checkout procedures when applicable.

8. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable). Measure and record motor amperage and voltage.

9. Install new filters where required.

10. Calibrate and adjust the airflow control parameters. Set applicable minimum and maximum setpoints. Coordinate with the BAS provider as necessary to obtain required flow parameters.

11. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure that it closes and seals tightly. Ensure the coils are undamaged, combed, and vented.

12. Ensure any hydronic heating elements are properly vented and that any associated strainers are clean.

13. Verify the integrity of any vibration isolation devices.

14. Verify that thermostats or temperature sensors are in a proper location to adequately represent space temperature. Verify temperature sensors not scheduled to be installed are secured properly on the top of the unit.

15. Temporary Closure: Verify VAV terminal units which are not scheduled to operate are provided temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris unit is scheduled to operate.

L. Fans – General Across Systems:

1. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to inspect the field assembly of components and installation of fans including ductwork, and electrical connections.
2. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Ensure that volatile irritants are contained and kept out of occupied spaces.

3. Vacuum clean the fan wheel, fan cabinet, and entering air face of coils.

4. Adjust and lubricate dampers and linkages for proper damper operation.

5. Verify that the unit is secure on mountings and supporting devices and that connections for ductwork and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.

6. Ensure that vibration isolation integrity is maintained with the fan installation and connections to the fan.

7. Refer to AC Motors in this Section.

8. Properly align and tension all belts. Record tensioning parameters in the Prefunctional Checklists.

9. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align belts, and install belt guards.

10. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

11. Stroke all dampers to ensure free and full travel.

12. Refer to Division 25, BAS Commissioning, for procedures on starting controls related to fans.

M. Metal Ductwork:

1. Inspect all ductwork for damage and dents and correct any deficiencies.

2. Check ductwork system to ensure that all required dampers, vanes, access doors, testing ports, and other appurtenances are required per the Contract Documents.

3. Check all penetrations through building elements and ensure tightness and integrity of fire ratings.

4. Leakage Tests: After each ductwork system that is constructed for ductwork pressure classification over 3 inches is completed, test for ductwork leakage in accordance with Section 23 31 00.

5. Clean ductwork internally of dust and debris, unit by unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

6. Strip protective paper from stainless steel ductwork surfaces and repair finish wherever the finish has been damaged.
7. Temporary Closure: At ends of ductwork 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 that will prevent entrance of dust and debris until final ductwork connections are to be completed.

8. Check pressure class of ductwork against fan dead head to verify adequacy.

N. Ductwork Accessories:

1. Inspect and operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

2. Develop a checkout sheet for all fire dampers. Physically inspect and operate every fire damper.

3. Install fusible links in fire dampers and adjust for proper action.

4. Label access doors in accordance with Contract Documents.

5. Fire Damper Testing: Coordinate with the local authority. For every fire damper, remove the fusible link and verify that the damper operates freely and closes tightly. Reinstall the fusible link.

6. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

O. Building Automation System:

1. Start-Up: Refer to Division 25, BAS Commissioning. This Division requires the manufacturer’s authorized representative to Start-up, test, adjust, and calibrate DDC control systems and to demonstrate compliance with Contract Document requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

2. Inspect installation for conformance to manufacturer’s requirements.

3. Verify controls for seasonal isolation and for modulation.

4. Verify discharge high limit controls are installed and functioning. Record limit setpoint and operating parameters.

P. Plate And Frame Heat Exchangers:

1. Inspect installation for conformance to the manufacturer’s requirements.

2. Check piping connections to ensure that connections are per the Contract Documents.

3. Verify that all labeling is affixed and that all appurtenances are install and accessible.

4. Confirm that all required O&M documentation is at the Project Site.

5. Verify that plates are tight and that bolts are evenly torqued.
6. Check inlet and outlet terminations to verify that piping is properly connected.

3.02 ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in the Specification Sections applicable to the systems being tested. Unless indicated otherwise, acceptance criteria will be specified with the individual system, equipment, component, or device.

3.03 TRAINING

A. Training requirements are specified in Specification Section 01 79 00 – Demonstration and Training.

END OF SECTION 20 08 13
EXAMPLE - PREFUNCTIONAL CHECKLIST
HVAC Pumps

Project: ___________________________ Project #: _______________________

Identification of Equipment or System: ______________________________________

Location of Equipment or System: ___________________________________________

Specification Section: ___________________ Detail/Drawing Number: _____________

Manufacturer / Supplier: _____________________________________________________

This Date: ___________________ Inspection Requested for (Date): _______________

PREFUNCTIONAL CHECKLIST NUMBER: __________

Components Included:
___ Valves, ___ Gauges, ___ Strainer, ___ Vibration isolators, ___ Base

Associated Prefunctional Checklists:
___ Piping, ___ Tubing, ___ Other________________________

1. General:
   a. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

   b. ___ Deficiency Form attached.

   c. This Prefunctional Checklist does not take the place of the manufacturer’s recommended checkout and start-up procedures or report.

   d. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.

   e. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.
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<td>CA</td>
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2. Requested Documentation Submitted:

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</tr>
<tr>
<td>GPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head (Ft)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Horsepower (hp)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage/Phase</td>
<td></td>
<td></td>
<td></td>
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</table>

4. Installation Checks:

<table>
<thead>
<tr>
<th>a) Unit and General Installation</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Permanent labels affixed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Housing condition good – no leaks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Pumps mounted on base</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The University of Texas
MD Anderson Cancer Center
ATTACHMENT "A" TO HVAC/PLUMBING/FIRE SUPPRESSION SYSTEMS PREFUNCTIONAL CHECKLIST AND START-UPS
20 08 13 A
2 OF 8
<table>
<thead>
<tr>
<th>a) Unit and General Installation</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Alignment appears correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Vibration isolation equipment installed and active</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Maintenance access acceptable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Coupling guard(s) installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Pump lubricated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Instrumentation installed correctly per Contract Documents (thermowells, thermometers, pressure gages, flow meters, transmitters, sensors)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Equipment clean</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Valves and Piping (immediately around pump)</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pipe fittings complete and pipes properly supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Pipe pressure test compete and acceptable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Flexible pipe installed at pump connections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Pipes properly insulated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Pipes properly labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Piping system properly flushed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Piping system charged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. No leaking evident around fittings or components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Strainer(s) installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Strainer(s) clean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Valves properly labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Valves installed in proper direction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Isolation valves open and close</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c) Electrical and Controls</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. HOA switch installed and functioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Panel power source identified</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Panel labeled with permanent label</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Power disconnect in place and labeled</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5. Low voltage wiring in separate conduit as 120 vac</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. 120 vac lightning protection installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Low voltage lightning protection installed (underground only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Pneumatic devices separated from controller and electronics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. End-of-line devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Panel devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I/O devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Digital inputs and outputs operational</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Controller drawing and point summary log in panel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. All electric connections tight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Proper grounding installed for components and unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Safetys in place and operable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Electrical and Controls</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>17.</td>
<td>Starter overload breakers installed and correct size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Sensors calibrated (see below)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Control system interlocks hooked up and functional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>All control devices, pneumatic tubing and wiring complete</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
d) Variable Frequency Drive

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>VFD Prefunctional Checklist complete and approved</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


e) Final

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Start-up report completed and attached with this Prefunctional Checklist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Safeties and safe operating ranges for this equipment have been reviewed and accepted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Sequence of operation adequately indicates all information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>System is ready for Functional Performance Test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Operational Checks:

a. These checks supplement the manufacturer's list. This is not the Functional Performance Test.

<table>
<thead>
<tr>
<th>Operational Checks</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pump(s) rotation correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Pump Phase Checks (%Imbalance = 100 x (avg. – lowest) / avg.). Imbalance less than 2%?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. All pumps running less than maximum FL amps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Pump noise and vibration acceptable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Cavitation exists</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Valves stroke fully and easily</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Specified sequences of operation and operating schedules have been implemented with all variations documented</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Specified point-to-point checks have been completed and documentation record submitted for this system</td>
<td></td>
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<tr>
<td>9. Record full load running amps for each pump.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pump No.</th>
<th>____________</th>
<th>____________</th>
<th>____________</th>
<th>____________</th>
<th>____________</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______ rated FL amps x _______ srvc factor = _______ (Max amps)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

6. Sensor and/or Actuator Calibration:

a. All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.
b. All test instruments have had a certified calibration within the last 12-months: Y / N

c. Sensor/Actuator Verification Table

<table>
<thead>
<tr>
<th>Sensor or Actuator</th>
<th>Correct Location (Y/N) (1)</th>
<th>Thermometer or Gage Value</th>
<th>BAS Value (2)</th>
<th>Instrument Measured Value (3)</th>
<th>Pass (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suction Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differential Pressure</td>
<td></td>
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</tbody>
</table>

1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.

2. BAS is the Building Automation System. Instrument = testing instrument.

3. **All sensors are calibrated within required tolerances ____ YES ____ NO**
# FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Print Name:</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Signature:</td>
</tr>
<tr>
<td></td>
<td>Title:</td>
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<td></td>
<td>Date:</td>
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<table>
<thead>
<tr>
<th>Mechanical Subcontractor</th>
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<tr>
<td></td>
<td>Signature:</td>
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<td></td>
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<tr>
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<table>
<thead>
<tr>
<th>Other Subcontractor:</th>
<th>Print Name:</th>
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<td></td>
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<td></td>
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Prefunctional Checklist received and reviewed for completeness by MD ANDERSON representatives. Functional Performance Test can proceed.

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EXAMPLE - PREFUNCTIONAL CHECKLIST
Air Handling Units - Modular

Project: ___________________________ Project #: ___________________________

Identification of Equipment or System: __________________________________________

Location of Equipment or System: ____________________________________________

Specification Section: ____________________ Detail/Drawing Number: ______________

Manufacturer / Supplier: ______________________________________________________

This Date: __________________ Inspection Requested for (Date): __________________

PREFUNCTIONAL CHECKLIST NUMBER: __________

Components Included:
___ Supply Fan, ___ Return Fan, ___ Cooling Coil(s), ___ Valves, ___ Control Dampers

Associated Prefunctional Checklists:
___ Chilled Water Piping, ___ Hot Water Piping, ___ Exhaust Fans, ___ Terminal Units, ___ VFD,
___ Smoke Dampers, ___ Fire Dampers, ___ Other __________________

1. General:
   a. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

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<tr>
<td>Service</td>
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</tr>
<tr>
<td>Sensible Capacity (BTU/hr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Capacity (BTU/hr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan CFM (Total)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Motor Horsepower (hp)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage/Phase</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Installation Checks:

a) Unit and General Installation          Yes No Comments
1. Permanent labels affixed
### a) Unit and General Installation

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Casing condition good – no dents, leaks; door gaskets installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Access doors close tightly – no apparent leaks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Flexible duct between unit and rigid duct tight; in good condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Vibration isolation equipment installed and active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Maintenance access acceptable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Thermal insulation installed properly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Instrumentation installed correctly per Contract Documents (thermowells, thermometers, pressure gages, flow meters, transmitters, sensors)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Equipment clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Filters clean with correct efficiency or MERV installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Filter frame housing installation allows for easy filter replacement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Filter pressure differential measuring device installed and functional (maghelic, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Electronic filtration installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Electronic filtration operational</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### b) Valves, Piping, and Coils

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pipe fittings complete and pipes properly supported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Pipes properly labeled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Pipes properly insulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Piping system properly flushed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Piping system charged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>No leaking evident around fittings or components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Coils are clean, fins are in good condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Condensate drain pan(s) installed, clean, sloped properly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Condensate drain line(s) installed and supported correctly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Control valve and isolation valves installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Valves properly labeled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Valves installed in proper direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Isolation valves open and close</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Outside air (OA) temperature, mixed air temperature, supply air temperature, return air temperature, chilled water supply/return sensors properly located and secure (related OA temperature sensor shielded)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Sensors calibrated (see calibration section below)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Pressure/temperature plugs and isolation valves installed per Contract Documents</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### c) Fans and Dampers

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Supply fan and motor alignment correct</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
c) Fans and Dampers

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td></td>
<td>Supply fan belt tension and condition good</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Supply fan protective shrouds for belts in place and secure</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Supply fan area clean</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Supply fan and motor lube lines installed and lubed</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Return fan and motor alignment correct</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Return fan belt tension and condition good</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Return fan protective shrouds for belts in place and secure</td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>Return fan area clean</td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>Return fan and motor lube lines installed and lubed</td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td>Exhaust fan Checklists for service area complete</td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td>Smoke and fire dampers installed properly per Contract Documents (proper location, access doors, appropriate ratings verified)</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>All isolation and smoke dampers close and seal properly</td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>All dampers (outside air, return air, supply air) stroke fully without binding</td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td>All damper linkages have minimum play</td>
</tr>
</tbody>
</table>

d) Duct

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>Sound attenuators installed</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Duct joint sealant properly installed</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>No apparent severe duct restrictions</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Turning vanes in square elbows as per Contract Documents</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Outside air intakes located away from pollutant sources and exhaust outlets</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Pressure leakage tests completed</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Branch duct control dampers operable</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Ducts cleaned as per Contract documents</td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>Terminal units installed, Checklist complete</td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>Balancing dampers installed per Contract Documents and TAB Firm’s direction</td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td>Supply and return air devices installed</td>
</tr>
</tbody>
</table>

e) Electrical and Controls

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>HOA switch installed and functioning</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Panel power source identified</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Panel labeled with permanent label</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Power disconnect in place and labeled</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Low voltage wiring in separate conduit as 120 vac</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>120 vac lightning protection installed</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Low voltage lightning protection installed (underground only)</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Pneumatic devices separated from controller and electronics</td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>End-of-line devices labeled and wiring tagged per Contract</td>
</tr>
</tbody>
</table>
e) Electrical and Controls

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Panel devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>I/O devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Digital inputs and outputs operational</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Controller drawing and point summary log in panel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>All electric connections tight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Proper grounding installed for components and unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Safeties in place and operable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Starter overload breakers installed and correct size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Sensors calibrated (see below)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Control system interlocks hooked up and functional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Smoke detectors in place</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>All control devices, pneumatic tubing and wiring complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>All casing wall penetrations including control wiring are properly sealed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

f) Variable Frequency Drive

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>VFD Prefunctional Checklist complete and approved</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

h) Final

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Start-up report completed and attached with this Prefunctional Checklist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Safeties and safe operating ranges for this equipment have been reviewed and accepted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Sequence of operation adequately indicates all information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Fire/smoke dampers and terminal units are open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Construction filters installed on return air devices to minimize dirt in ductwork and coils and in any finished areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Verification of potential moisture migration has been performed via inspection of wall/building construction and review of operating sequences for all make-up air, outside air, supply, return, and exhaust fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>System is ready for Functional Performance Test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Operational Checks:

   a. These checks supplement the manufacturer’s list. This is not the Functional Performance Test.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
</table>
### Operational Checks

<table>
<thead>
<tr>
<th>Operational Checks</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply fan rotation correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Fans &gt; 5 Hp Phase Checks (%Imbalance = 100 x (avg. – lowest) / avg.). Imbalance less than 2%?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. All fans running less than maximum FL amps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Return fan noise and vibration acceptable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Supply fan has no unusual noise or vibration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Valves stroke fully and easily</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Valves verified not to leak through coils when closed at normal operating pressure</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8. The HOA switch properly activates and deactivates the unit</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9. Specified sequences of operation and operating schedules have been implemented with all variations documented</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Specified point-to-point checks have been completed and documentation record submitted for this system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Record full load running amps for each pump.</td>
<td></td>
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</tr>
</tbody>
</table>

**SF Fan No. ____:**  
Rated FL amps x svc factor = Max amps

**RF Fan No. ____:**  
Rated FL amps x svc factor = Max amps

### Sensor and/or Actuator Calibration:

- **a.** All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.

- **b.** All test instruments have had a certified calibration within the last 12-months: Y / N

- **c.** Sensor/Actuator Verification Table (AHU in Operation)

<table>
<thead>
<tr>
<th>Sensor or Actuator</th>
<th>Correct Location (Y/N)</th>
<th>Thermometer or Gage Value</th>
<th>BAS Value (2)</th>
<th>Instrument Measured Value (3)</th>
<th>Pass (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply air discharge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHWR (at AHU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHWS (at AHU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duct SP (at SA discharge)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHW Control Valve Position</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HWR (at AHU)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.

2. BAS is the Building Automation System. Instrument = testing instrument.

3. **All sensors are calibrated within required tolerances**  ___ YES  ___ NO
## FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.

<table>
<thead>
<tr>
<th>Role</th>
<th>Print Name</th>
<th>Signature</th>
<th>Title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Subcontractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Subcontractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prefunctional Checklist received and reviewed for completeness by MD ANDERSON representatives. Functional Performance Test can proceed.

<table>
<thead>
<tr>
<th>Role</th>
<th>Print Name</th>
<th>Signature</th>
<th>Title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD ANDERSON:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The University of Texas MD Anderson Cancer Center ATTACHMENT “B” TO HVAC/PLUMBING/FIRE SUPPRESSION SYSTEMS PREFUNCTIONAL CHECKLIST AND START-UPS 20 08 13 B MS052616
<table>
<thead>
<tr>
<th>Title:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
</tr>
</tbody>
</table>
EXAMPLE - PREFUNCTIONAL CHECKLIST

Terminal Units

Project: ___________________________ Project #: ___________________________

Identification of Equipment or System: _______________________________________

Location of Equipment or System: ____________________________________________

Specification Section: ____________________ Detail/Drawing Number: ______________

Manufacturer / Supplier: ______________________________________________________

This Date: ____________________ Inspection Requested for (Date): ______________

PREFUNCTIONAL CHECKLIST NUMBER: _________

Components Included:
___ Damper, ___ Temperature Sensor, ___ Heating Coil, ___ Fan

Associated Prefunctional Checklists:
___ AHU- _______, ___ Other __________________________

1. General:

a. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

b. ___ Deficiency Form attached.

c. This Prefunctional Checklist does not take the place of the manufacturer’s recommended checkout and start-up procedures or report.

d. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.

e. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.
### Contractor/Entity | Company | Abbreviation
--- | --- | ---
MD Anderson Staff | MD ANDERSON | MD ANDERSON
Architect/Engineer | | A/E
General Contractor / Construction Manager | | GC
Mechanical Contractor | | MC
Electrical Contractor | | EC
Building Automation System Provider | | BAS
Test, Adjust, and Balance Firm | | TAB
Commissioning Consultant | | CA

2. **Requested Documentation Submitted:**

<table>
<thead>
<tr>
<th>Specified Requirement</th>
<th>Yes</th>
<th>No</th>
<th>Date to be Submitted</th>
</tr>
</thead>
</table>
a) Manufacturer’s Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer | | | |
b) Required Test Reports and/or Certifications | | | |
c) Installation and Start-up Manual and Plan | | | |
d) Wiring Diagrams, Control Schematics and Sequences | | | |
e) Operating and Maintenance Manual Content for Applicable System | | | |
f) Equipment Matrix | | | |

3. **Equipment Verification:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Specified</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
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</tr>
<tr>
<td>Serial Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity (CFM)</td>
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<td></td>
</tr>
<tr>
<td>Maximum CFM</td>
<td></td>
<td></td>
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<tr>
<td>Minimum CFM</td>
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<tr>
<td>Fan Motor Horsepower (hp)</td>
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<td></td>
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<tr>
<td>Fan Voltage/Phase</td>
<td></td>
<td></td>
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<tr>
<td>Electric Heat (kW) if applicable</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

4. **Installation Checks:**

<table>
<thead>
<tr>
<th>a) Unit and General Installation</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Permanent labels affixed</td>
<td></td>
<td></td>
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<tr>
<td>2. Permanent label affixed within building space identifying location</td>
<td></td>
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</table>
**a) Unit and General Installation**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
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<tbody>
<tr>
<td>3</td>
<td>Casing condition good – no dents, leaks; door gaskets installed</td>
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<td>4</td>
<td>Access doors close tightly – no apparent leaks</td>
<td></td>
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<tr>
<td>5</td>
<td>Hard duct connecting high/medium pressure duct to unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Vibration isolation equipment installed and active</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td>Maintenance access acceptable</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td>Sound attenuation installed properly</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>Instrumentation installed correctly per Contract Documents</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td>Equipment clean</td>
<td></td>
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</table>

**b) Heating Coil**

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<th>Item Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Pipe fittings complete and pipes properly supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Pipes properly labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Pipes properly insulated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>No leaking evident around fittings or components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Coils are clean, fins are in good condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Valves properly labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Control valve installed and wired properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Valves installed in proper direction</td>
<td></td>
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</tbody>
</table>

**c) Fans and Dampers**

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<th>No.</th>
<th>Item Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fan and motor alignment correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fan area clean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fan responds to temperature sensor settings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Damper installed properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Damper closes and opens properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Damper linkages have minimum play</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

**d) Electrical and Controls**

<table>
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<th>Item Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature sensor location accessible for maintenance</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Temperature sensor not damaged</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Temperature sensor labeled with respect to terminal unit and air handler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Panel power source identified</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>Power disconnect for electric heating coil and/or fan in place and labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Panel devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I/O devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Digital inputs and outputs operational</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Controller drawing and point summary log in panel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>All electric connections tight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Proper grounding installed for components and unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Safeties in place and operable</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
d) Electrical and Controls

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>Sensors calibrated (see below)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Control system interlocks hooked up and functional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>All control devices and wiring complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>All control devices, pneumatic tubing and wiring complete</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

f) Variable Frequency Drive

<table>
<thead>
<tr>
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<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>VFD Prefunctional Checklist complete and approved</td>
<td></td>
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</tbody>
</table>

h) Final

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Start-up report completed and attached with this Prefunctional Checklist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Safeties and safe operating ranges for this equipment have been reviewed and accepted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Sequence of operation adequately indicates all information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Terminal unit damper open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>System is ready for Functional Performance Test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Operational Checks:

a. These checks supplement the manufacturer’s list. This is not the Functional Performance Test.

<table>
<thead>
<tr>
<th>Operational Checks</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acuated damper(s) responds to sensor temperature settings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan rotation correct</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. Record full load running amps for fan:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fan No. _____: ____ rated FL amps x ______ svc factor = _______ (Max amps)</td>
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<td></td>
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<tr>
<td>3. Fan running less than maximum FL amps</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4. Fan noise and vibration acceptable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Fan responds to temperature sensor settings</td>
<td></td>
<td></td>
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<tr>
<td>6. Heating coil responds to temperature sensor settings</td>
<td></td>
<td></td>
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<tr>
<td>8. Disconnect switch properly activates and deactivates the heating coil</td>
<td></td>
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<tr>
<td>9. Specified sequences of operation and operating schedules have been implemented with all variations documented</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Specified point-to-point checks have been completed and documentation record submitted for this system</td>
<td></td>
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</tr>
</tbody>
</table>

6. Sensor and/or Actuator Calibration:

a. All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.
b. All test instruments have had a certified calibration within the last 12-months:  Y / N

c. Sensor/Actuator Verification Table

<table>
<thead>
<tr>
<th>Sensor or Actuator</th>
<th>Correct Location (Y/N) (1)</th>
<th>Thermometer or Gage Value</th>
<th>BAS Value (2)</th>
<th>Instrument Measured Value (3)</th>
<th>Pass (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Sensor</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.
2. BAS is the Building Automation System. Instrument = testing instrument.

3. **All sensors are calibrated within required tolerances ___ YES ___ NO**
## FINAL SIGN-OFF

Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.

<table>
<thead>
<tr>
<th>General Contractor:</th>
<th>Print Name:</th>
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Prefunctional Checklist received and reviewed for completeness by MD ANDERSON representatives. Functional Performance Test can proceed.

<table>
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<tr>
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<th>Print Name:</th>
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SECTION 20 08 16 – HVAC/PLUMBING/FIRE SUPPRESSION SYSTEMS FUNCTIONAL PERFORMANCE TESTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section expands on and defines responsibilities of the Contractor in regards to Functional Performance Tests (FPT's) of the Commissioning process.

B. Contractor shall oversee the Commissioning activities with the Contractor’s Subcontractors and the Architect/Engineer (A/E).

C. Prefunctional Checklists, tests and Start-ups are to be completed and documented for the record prior to commencing with FPT’s. Refer to Section 20 08 00 and 20 08 13 for additional requirements.

D. Completed FPT Forms for all pieces of equipment and systems shall be submitted to the Owner prior to Substantial Completion.

E. Refer to Attachments A and B at the end of this Section for example forms that indicate level of documentation required for the Commissioning process.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 SUBMITTALS

A. Maintain and use an action item tracking system, “Action Item List,” that indicates as a minimum, required information, identified deficiencies, work required, etc.). Each item shall be tracked with the initiator, the parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms. Action Item List shall be distributed and documented using Microsoft Excel or a database format approved by Owner.
B. Disseminate this list as appropriate to keep all parties involved with the FPT informed.

C. Functional Performance Test procedure forms must include the following:

1. System and equipment or component name(s).

2. Equipment location and identification number as identified in the Equipment Matrix described in Division 01.

3. Unique test identification number and reference to unique Prefunctional Checklist and Start-up Documentation Identification Numbers for the equipment.

4. Date and time of test.

5. Project name.

6. Participating parties.

7. Specific sequence of operation or other specified parameters, including performance data being verified.

8. Instructions for setting up a Functional Performance Test.

9. Specific script-type, step-by-step procedures to perform a Functional Performance Test, in a clear, sequential and repeatable format that is customized for the system being tested.

10. A Yes/No checkbox (or data entry box as appropriate) for clearly indicating whether or not proper performance of each part of a Functional Performance Test was achieved with space for actual readings.

11. Section for comments.

12. Signatures and date block for participants and Owner approvals.

D. Refer to Division 01 and 20 08 00 for additional documentation requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 TEST EQUIPMENT

A. Refer to Specification Section 01 91 00 – General Commissioning Requirements.
PART 3 - EXECUTION

3.01 PREPARATION

A. The objective of FPT’s is to demonstrate that each system operates according to the Contract Documents through all specified modes of operation.

B. Contractor shall operate each system through all modes of operation (occupied, unoccupied, warm-up, cool-down, etc.) where there is a specified system response. Verification of each sequence in the sequences of operation is required.

C. All equipment, components and devices applicable to the FPT must be started and this Start-up must be documented. This documentation includes completion of the Prefunctional Checklists, pressure testing of equipment, duct, pipe, etc., flushing/cleaning of applicable systems, completed labeling and identification, completed insulation of applicable systems, etc. Refer to Section 20 08 13 for additional Prefunctional Checklist and Start-up requirements.

D. Unless specifically agreed to by the Commissioning Team, all support systems shall be complete prior to FPT.
   1. The electrical system serving it is completed and tested.
   2. The hydronic systems serving it have been balanced and FPT completed.
   3. Balancing has been accomplished on the air and water sides.
   4. The building automation system (BAS) has been started and calibrated.

E. Commissioning Team members shall assist in development and review of the optimal sequence of testing.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.03 FUNCTIONAL PERFORMANCE TEST PROCEDURES

A. The purpose of a Functional Performance Test is to verify and document compliance with the stated criteria of acceptance. Contractor shall develop specific script-type test procedures and associated test forms to verify and document proper operation of each piece of equipment and system.

B. Contractor shall operate, or cause to be operated, each system, device, or equipment item, both intermittently and continuously, for a duration period as indicated in the Specification Section(s) for such item and/or in accordance with the manufacturer’s written recommendations, the Contract Documents, and the Commissioning Plan.

C. Contractor shall operate each component device and each building system to the full extent of its capability, from minimum to maximum, and under automatic control and manual control.
D. Contractor and manufacturer’s representatives shall supervise and coordinate adjustments and balancing of all devices and systems for proper operation prior to requesting the Functional Performance Test(s).

E. Where final balancing of a system is to be performed by Owner or Owner’s consultants, such as final air balancing, Contractor shall provide all services indicated in the applicable Technical Sections and under this Section, including the following prior to Owner’s final balancing:

1. Operational verification of all component devices and the total system, including automatic controls when applicable. Operational verification includes verification that all motors, fans, dampers, and other operable devices are performing in compliance with Specifications throughout their operable range and that all devices are controlled as described in the specified sequence of operation.

2. All tabulated data, motor amperage readings, valve tag verifications, and other data required by Technical Specifications.

F. Where final balancing of a system or particular components of a system are not specifically indicated to be performed by Owner or Owner’s consultants, Contractor shall provide final balancing and adjustments for operation within specified tolerances prior to Functional Performance Test of such system.

G. Sampling: Some types of identical equipment (such as terminal devices) will be tested using a sampling strategy. The sample percentage is indicated below. [Insert equipment list and sampling percentage.]

H. Failure Limit on Sample Tests: With the sampling percentages is listed a failure limit. This limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.

   1. Where sample tests involve multiple systems (i.e.: Checking strainers on different hydronic systems) the maximum failure limit will apply per system.

I. Deferred Tests: Contractor shall schedule with the Owner and complete Deferred Tests as part of this Contract during the Warranty Period. Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. Deferred or “Opposite season” tests will be required where scheduling prohibits thorough testing in all modes of operation. Air Handler and central heating system testing for heating related modes of operation and control loops shall be tested during outside air temperatures below 50 degrees F. Air handler and central cooling system testing for cooling related modes of operation and control loops shall be tested during outside air temperatures above 85 degrees F.

J. Provide and deliver the required submitted documentation convenient to testing area. Validate that all required documentation has been submitted to the Owner and is per the Contract Document requirements.
K. Review the Start-up documentation at the start of FPT’s. Ensure that any items indicated as outstanding in the Prefunctional Checklist is entered as an Action Item and enter one if it is not. The Prefunctional Checklists and Start-up tests/measurements shall be spot checked at the beginning of FPT’s to ensure accuracy. Complete a test that indicates Contractor has reviewed the Prefunctional Checklists and finds the Prefunctional Checklists acceptable and notes any outstanding items.

L. Check for and as applicable direct the Subcontractor to demonstrate that access is sufficient to perform required maintenance.

M. Validate that all prerequisite work is complete and confirm this validation via a test record for documentation.

N. Specifically check labeling and ensure conformance to the Contract Documents.

O. Analyze trends of the system operating parameters to evaluate normal system functionality. The trending requirements are specified in the BAS Commissioning Specification, however all systems must be trended and reviewed prior to and as part of functional performance trending. Subcontractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the Contractor. Analyzed trends shall be organized and/or grouped in a manner that clearly demonstrates the individual components of a piece of equipment is under total control and display this information together. The trend group data shall be labeled with the system name or the purpose of the trend group or data and submitted in a Microsoft Excel spreadsheet.

P. Check proof indication, alarming on failure and restart/acknowledgement as applicable.

Q. Observe operating conditions encountered at the start of the FPT. Contractor shall examine for normal functionality and record parameters as a test.

R. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on emergency power or uninterruptible power shall be tested on all sources. This test shall generally be coordinated with electrical power systems testing addressed in the Contract Documents.

1. Emergency power tests for mechanical systems will be conducted in concert with the testing of the emergency power systems. Testing Contractor shall be available for the power outage test to test their systems under a power outage. This is in addition to the requirement specified by system.

S. Inspect the installation and compare it to the Contract Documents. Record the inspection as a test.

T. Capacities and adjusted and balanced conditions as applicable will generally be checked.

U. Verify all sequence modes and sequences of operation. Contractor must initiate all modes and may not refer to or rely on a Prefunctional Test done by the building automation system. Some examples of generic modes that apply to most systems include:

1. Off mode.

2. Failed mode: Proof, safeties, power outage etc. See below for crash testing.
3. Start sequence in various modes.

4. Stop sequences in various modes.

V. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation. The Contractor is responsible for placing systems in optimal condition for occupancy and not simply relying on initial design estimated settings.

W. Dynamic Graphics: The graphic for all components, systems, and areas sampled and required to be represented by a graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints are required to be adjustable, verify that they can be adjusted directly from the graphic screen.

X. All interfaces between two systems or equipment of different manufacturers must be checked for accuracy and functionality.

Y. Contractor shall to the extent possible, load the heating and cooling systems during initial FPT’s to check the capacity of the building central systems and initially optimize system settings. This will typically be done using the preheat system to false load the cooling system. This test will incorporate varying the load to check central systems response.

Z. “Crash Testing”: Contractor shall analyze systems to identify possible conditions where functionality may be compromised. Contractor shall design non-destructive tests that will demonstrate either the automated response to the conditions or so that team can identify the best method for responding or fixing the condition. All tests and their findings shall be documented in a Microsoft Excel spreadsheet.

3.04 PARTICIPATION

A. Required participating parties are indicated with the individual tests. Typically, multiple parties are required for any given test, yet participation for any given party is only required for the respective portion of the test for which the party is responsible. In many cases, the maximum required time in hours is indicated in parenthesis for any given test. The time is typically per unit system unless indicated otherwise. If no time is indicated, participation is required throughout the entire test.

B. Frequently, on multiple samples where a given party does not directly conduct the test, the participation of that party will only be required for an initial quantity of systems/equipment. It is required that the parties be available on-site throughout the testing of any given system for which they are required participants. Therefore time for which they are not directly involved can be spent performing other work (typically addressing identified punch list items or failed test).

C. No party involved with the Project is prohibited from participation in or witnessing of any tests. Any Subcontractor may elect to witness all tests on their systems even if their involvement is not directly required.

D. Coordinate effectively with the individual Subcontractors throughout the development and execution of FPT’s and maximize Subcontractors’ involvement.
3.05 ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in the Specification Sections applicable to the systems being tested. Unless indicated otherwise, acceptance criteria will be specified with the individual system, equipment, component, or device.

END OF SECTION 20 08 16
EXAMPLE – FUNCTIONAL PERFORMANCE TEST
HVAC Pumps

Project: ___________________________  Project #: ______________________

Identification of Equipment or System: _______________________________________

Location of Equipment or System: ____________________________________________

Specification Section: _______________  Detail/Drawing Number: _______________

Manufacturer / Supplier: ______________________________________________________

This Date: ________________  Time of Test: __________________

FUNCTIONAL PERFORMANCE TEST PROCEDURE NUMBER: ______________

PREFUNCTIONAL CHECKLIST NUMBER: ______________

Components Included:
___ VFD for pump, ___ Heat Exchanger, ___ Other _______________________________

Other Related Functional Performance Tests: __________________________________

1. General:
   a. This Functional Performance Test is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Commissioning Deficiency Report upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.
   
   b. ___ Commissioning Deficiency Report attached.

2. Participants:

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Role/Participation</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>
3. Functional Performance Test Prerequisites:

<table>
<thead>
<tr>
<th>Specified Requirement</th>
<th>Yes</th>
<th>No</th>
<th>Date to be Submitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The Prefunctional Checklist for this system is complete and approved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) The Prefunctional Checklist for the pump variable frequency drive system is complete and approved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) The Prefunctional Checklist for the air handling unit related to this pump variable frequency drive system is complete and approved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) All Architect/Engineer punchlist items for this system and related equipment have been addressed and corrected</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>e) Sequence of operation is attached</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>f) Test, adjust, and balance (TAB) completed and approved for the associated systems</td>
<td></td>
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</tr>
<tr>
<td>g) TAB report provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Design setpoint information included on forms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controls:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) DDC loops operational, temperature/pressure setpoints met without hunting</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ii) Master transmission diagram is updated on device graph</td>
<td></td>
<td></td>
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<tr>
<td>iii) Graphic programming is complete and operational</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>iv) System communicates with main controller</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v) Pump is set to design/final setpoints</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi) Local reading of setpoints agree with remote readings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) These Functional Performance Test procedures have been reviewed and approved by installing contractor and applicable subcontractors</td>
<td></td>
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</tr>
</tbody>
</table>

4. Functional Performance Test Procedure:

<table>
<thead>
<tr>
<th>Step</th>
<th>Mode</th>
<th>Test Procedure</th>
<th>Expected Response</th>
<th>Pass</th>
</tr>
</thead>
</table>
| 1    | Pump Off      | Standby check. HOA in Auto position. Unit commanded Off by BAS. | Verify by visual inspection that:  
   a) Discharge gauge pressure equals suction gauge pressure.  
   b) No rotation of pump shaft.  
   c) Pump light indication shows pump is Off.  
   Pump indication shows pump as being Off at the BAS. |      |
| 2    | Pump Start-up | HOA in Auto position. Unit commanded On by BAS.     | Verify by visual inspection that:  
   a) Discharge gauge pressure greater than suction gauge pressure.  
   b) Rotation of pump shaft.  
   c) Pump light indication shows pump is On.  
   Pump indication shows pump as being On at the BAS. |      |
<table>
<thead>
<tr>
<th></th>
<th>Task Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Pump Operation</td>
<td>HOA in Auto position. Test results are recorded in table. Verify by local and remote reading that test results correspond with TAB report and sequence of operation as described in the Contract Documents.</td>
</tr>
<tr>
<td>4</td>
<td>Simulate Pump Overload Trip</td>
<td>HOA in Auto position. Test results are recorded in table. BAS indicates an alarm for Pump Trip condition.</td>
</tr>
<tr>
<td>5</td>
<td>Simulate Loss of Pump Flow</td>
<td>HOA in Auto position. Test results are recorded in table. Isolate DP switch across suction and discharge of pump and open sensing line vent valves to relieve pressure across DP switch. BAS indicates an alarm condition for Loss of Pump condition.</td>
</tr>
</tbody>
</table>

5. Comments:
Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Commissioning Deficiency Report.

General Contractor:  Print Name:
Signature:
Title:
Date:

Mechanical Subcontractor  Print Name:
Signature:
Title:
Date:

Other Subcontractor:  Print Name:
Signature:
Title:
Date:

Functional Performance Test procedure received and reviewed for completeness by MD ANDERSON representatives. Integrated System Test can proceed.

MD ANDERSON:  Print Name:
Signature:
Title:
Date:

MD ANDERSON:  Print Name:
Signature:
Title:
Date:
 EXAMPLE – FUNCTIONAL PERFORMANCE TEST
Air Handling Units - Modular

Project: ____________________________  Project #: ____________________________

Identification of Equipment or System: ____________________________________________

Location of Equipment or System: ________________________________________________

Specification Section: ___________________________  Detail/Drawing Number: __________

Manufacturer / Supplier: _________________________________________________________

This Date: ________________  Time of Test: ________________

FUNCTIONAL PERFORMANCE TEST PROCEDURE NUMBER: _________________________

PREFUNCTIONAL CHECKLIST NUMBER: __________

Components Included: ___ VFD for AHU, ___ Return Fans (RF), ___ Outside Air Handling Unit, AHU ________,
Other ________________________________________________

Other Related Functional Performance Tests: ______________________________________

1. General:

   a. This Functional Performance Test is submitted for approval and is subject to the attached list
      of outstanding items not completed successfully. Submit a Commissioning Deficiency Report
      upon completion of any outstanding or deficient items. None of the outstanding items
      preclude safe and reliable functional tests being performed.

   b. ___ Commissioning Deficiency Report attached.

2. Participants:

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Role/Participation</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

3. Functional Performance Test Prerequisites:

The University of Texas  ATTACHMENT “B” TO HVAC/PLUMBING/FIRE SUPPRESSION
MD Anderson Cancer Center  SYSTEMS FUNCTIONAL PERFORMANCE TESTS
MS052616
<table>
<thead>
<tr>
<th>Specified Requirement</th>
<th>Yes</th>
<th>No</th>
<th>Date to be Submitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The Prefunctional Checklist for this system is complete and approved</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>b) The Prefunctional Checklist for the following systems and components are complete and approved:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>i) Chilled water system</td>
<td></td>
<td></td>
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<tr>
<td>ii) Chilled water piping and valves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii) Condenser water pumps</td>
<td></td>
<td></td>
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<tr>
<td>iv) Cooling towers</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>iii) Associated terminal units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv) Variable frequency drives for associated pumps</td>
<td></td>
<td></td>
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<tr>
<td>c) All control system functions for this and all interlocking systems are programmed and operable per the Contract Documents including final setpoints and schedules with debugging, loop tuning, and sensor calibrations completed.</td>
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<tr>
<td>d) Piping system flushing complete and required test reports approved</td>
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<tr>
<td>e) Water treatment system complete and operational</td>
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<tr>
<td>f) Vibration control report approved</td>
<td></td>
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<tr>
<td>g) Test, adjust, and balance (TAB) completed and approved for the hydronic systems and associated terminal units.</td>
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<td></td>
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<tr>
<td>h) TAB report provided</td>
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<td></td>
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<tr>
<td>i) All Architect/Engineer punchlist items for this system and related equipment have been addressed and corrected</td>
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<tr>
<td>j) Safeties and operating ranges reviewed</td>
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<tr>
<td>k) Sequences of operation is attached</td>
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<td></td>
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<tr>
<td>l) Schedules and setpoints attached</td>
<td></td>
<td></td>
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<tr>
<td>m) False loading equipment, system, and procedures ready (boilers, preheat or reheat coils, control loops, override on outside air (OSA) dampers, etc.)</td>
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<tr>
<td>n) Have all energy savings control strategies, setpoints, and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below:</td>
<td></td>
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<tr>
<td>o) Control Program Review: Review the software control program(s) for this equipment. Parameters, setpoints, and logic sequences appear to follow the specified written sequences.</td>
<td></td>
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</tr>
<tr>
<td>p) These Functional Performance Test procedures have been reviewed and approved by installing contractor and applicable subcontractors</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
4. Current Setpoints for Functional Performance Test Procedure:

   c. Record all values for current setpoints (SP), control parameters, limits, delays, lockouts, schedules, etc., changed to accommodate testing.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-Test Values</th>
<th>Returned to Pre-Test Values</th>
<th>Parameter</th>
<th>Pre-Test Values</th>
<th>Returned to Pre-Test Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge air static pressure (SP)</td>
<td></td>
<td></td>
<td>Building static pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge air temp.</td>
<td></td>
<td></td>
<td>Dirty filter D.P.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static P. reset schedule</td>
<td></td>
<td></td>
<td>OSA CFM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge air reset schedule</td>
<td></td>
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</tr>
</tbody>
</table>

5. Sensor Calibration Checks:

   d. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during Prefunctional Checklist.

   e. “In calibration” means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the Prefunctional Checklist requirements (__________________________). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

<table>
<thead>
<tr>
<th>Sensor &amp; Location</th>
<th>Location OK</th>
<th>1st Gage or BAS Value</th>
<th>Instr. Meas’d Value</th>
<th>Final Gage or BAS Value</th>
<th>Pass Y/N?</th>
<th>Sensor &amp; Location</th>
<th>Location OK</th>
<th>1st Gage or BAS Value</th>
<th>Instr. Meas’d Value</th>
<th>Final Gage or BAS Value</th>
<th>Pass Y/N?</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Discharge SP</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>RAT</td>
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<tr>
<td>OSAT</td>
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</tbody>
</table>

Sensor location is appropriate and away from causes of erratic operation.

6. Device Calibration Checks:

   f. The actuators or devices listed below checked for calibration. This is a spot check on a sample of calibrations done during Prefunctional Checklist and start-up.

   g. “In calibration” means observing a readout in the BAS and going to the actuator or
controlled device and verifying that the BAS reading is correct. Fix items out of
calibration or adjustment, via an offset in the BAS, or a mechanical fix.

<table>
<thead>
<tr>
<th>Device or Actuator &amp; Location</th>
<th>Procedure / State</th>
<th>1st BAS Value</th>
<th>Site Observation</th>
<th>Final BAS Reading</th>
<th>Pass Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling coil valve (CCV)</td>
<td>1. Intermediate positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>3. Increase pressure (open)</td>
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<tr>
<td></td>
<td>4. Closed</td>
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<tr>
<td></td>
<td>5. Remove power or air (closed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relief damper position **</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Mixed air damper position **</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main OSA damper position**</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. OSA damper position**</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable frequency drive speed</td>
<td>1. Min.: ___________%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(VFD)***</td>
<td>2. Max.: __________%</td>
<td></td>
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</tr>
</tbody>
</table>

* Set pumps to normal mode. Procedure 1. Command valve to a few intermediate positions. Verify that readings in BAS reasonably correspond to the actual positions. For cooling coil valves (NO): Procedure 2. Lower space setpoint to 20 deg. F. below space temperature. Verify BAS reading says CCV is 100% open. Visually verify valve is 100% open. Procedure 3. For pneumatic actuators, by override in the BAS, increase pressure to valve by ____ psi (do not exceed actuator rating). Verify valve stem and actuator position does not change. Restore to normal. Procedure 4. Set space setpoint to 20F above space temperature. Verify BAS reading says CCV is closed. Visually verify valve is closed. Procedure 5. Remove control air or electricity from the valve and verify that the valve stem and actuator position do not change.

** 1. Command damper closed and verify that damper is shut and BAS reads shut.
2. Do the same, commanding damper fully open.

*** VFD: Procedure 1. Lower the controlling static pressure setpoint (duct or discharge) to be 1/4 of its current value. Verify that the vanes are shut, or fan speed is at minimum for VFD and packaged controller reads the same. Return the static pressure setpoint to normal. Procedure 2. Lower the space temperature setpoint to be 20F below space temperature and cause TU dampers to go to full cooling. Raise the static pressure setpoint as necessary to cause the setpoint to not be met. Verify that the inlet vanes are fully open or the fan speed is at its maximum and verify that the packaged controller reads the same. Return all to normal.

Notes:
7. Functional Performance Test Procedure:

<table>
<thead>
<tr>
<th>Step</th>
<th>Mode</th>
<th>Test Procedure</th>
<th>Expected Response</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fan Off</td>
<td>Standby check with units commanded Off by BAS.</td>
<td>Verify by visual inspection that:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. Return Air Dampers to AHU- are Open.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Outside Air Dampers in AHU- are Closed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Isolation Dampers on AHU- are Closed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Relief Dampers in RF- are Closed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. Cooling Coil Valve on Cooling Coil of AHU- is Closed.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Unit Start-up</td>
<td>With units commanded on by BAS.</td>
<td>1. Supply Fan Isolation Dampers Open in AHU-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Supply Fan start through VFDs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Supply Fan Isolation Dampers in AHU- Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. AHU- Fans Start</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. RF- Isolation Dampers Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6. RF- Fans start through VFDs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7. Exhaust Fans EF- start.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>RF Volume Control</td>
<td>1. Verify RF Volume, utilizing airflow meters in Return Fans RF____, Supply Fans in AHU-____ and Garage Exhaust Fan EF-1, and TAB established CFMs for Exhaust Fans EF-____, and ____, TAB established Fixed Differential, make the following calculation: (Return Air Flow=Supply Air Flow, - EF-</td>
<td>Verify that RF airflow meter readings correspond to calculation.</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Mode</td>
<td>Test Procedure</td>
<td>Expected Response</td>
<td>Pass</td>
</tr>
<tr>
<td>------</td>
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<td>------</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>1and2 Flow, -SF1 Flow-Fixed Differential</td>
<td>Verify that RF airflow meter readings continue to correspond to calculation</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2. Trend Log RF____, AHU ____ , and SF-1 airflow rates at 5 min. intervals. Command off EF-1 and 2 sequentially at 5 min. Intervals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Duct Static Pressure Control</td>
<td>Disable Duct Static Pressure Reset utilizing BAS Software. Adjust space temperature setpoint on significant quantity of zones to be well below observed reading.</td>
<td>Verify that VFD’s modulate as required to maintain SP setpoint without hunting or overshooting setpoint.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>High Static Pressure Alarm and Shutdown</td>
<td>With units running at low flow condition, utilizing a squeeze bulb, simulate an increase in discharge air static pressure.</td>
<td>Verify that BAS indicates an alarm condition at ____&quot;WG and shuts fans down at ____&quot;WG</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Static Pressure Reset</td>
<td>1. For Perimeter Terminal Units on floors 9-16, Reset space temperature setpoints to be below space temperatures. Utilizing BAS trend logging capabilities, Record at 5 min. intervals, Discharge Air SP Spt, Perimeter TU Units in saturation.  2. Reset space temperature setpoints to be above space temperatures. Utilizing the same Trending as above, Record the same data points.</td>
<td>Verify that DA SP Spts increase by ____&quot;WG at ____ min intervals until only one Perimeter TU remains in saturation. Verify that setpoints are met and maintained without excessive hunting.  Verify that DA SP Spt decreases by ____&quot;WG at ____ min intervals until one Perimeter TU reaches saturation.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Discharge Temp. Reset</td>
<td>1. For Perimeter Terminal Units Floors 1-2, Reset space sensor setpoints to be above space temperatures. Utilizing BAS Trend Logging, at 6 min intervals, record DAT setpoint, DAT, and perimeter TU cooling Flow rates.  2. For Perimeter Terminal Units Floors 1-2, Reset space sensor setpoints to be below space temperatures. Utilizing BAS Trend Logging, at 6 min intervals, record DAT setpoint, DAT, and perimeter TU cooling Flow rates.</td>
<td>Verify that Discharge Air Temperature Setpoint is reset upwards at 2 deg increments every 6 min to maintain design cooling CFM at 5 perimeter TU’s to maintain design cooling CFM  Verify that Discharge Air Temperature Setpoint is reset downwards at 2 deg increments every 6 min to reach design cooling CFM at only 5 perimeter TU’s. Both should happen without excessive hunting.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Smoke Conditions</td>
<td>Interfacing with EC, simulate a fire mode with the Fire Alarm System.</td>
<td>Verify that AHU System returns to FAN OFF Status, with OSA and Relief Dampers in a Closed</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Mode</td>
<td>Test Procedure</td>
<td>Expected Response</td>
<td>Pass</td>
</tr>
<tr>
<td>------</td>
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<td>------</td>
</tr>
<tr>
<td>9</td>
<td>Warm-up Control</td>
<td>Place Unit’s BAS Control Mode into Warmup. Overwrite RAT Sensor Reading to be 65 Deg. F.</td>
<td>Verify that dampers assume a 100% Return Air Mode.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Warm-up Control</td>
<td>Place Unit’s BAS Control Mode in Warmup. Overwrite RAT Sensor Reading to be ____ Deg. F.</td>
<td>Verify that unit returns to Normal Operation Mode.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Freeze Condition</td>
<td>Overwrite Low Limit Detection Thermostat reading to be ____ Deg. F.</td>
<td>Verify that system alarms, fans stop, OSA Dampers close, Relief Dampers Close, and RA dampers open.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Return Fan Static Pressure</td>
<td>With AHU Unit ___ running at low air flow condition, Overwrite RF ___ return air fan inlet SP to a reading below - ___ &quot; W.G.</td>
<td>Verify that system alarms and that all Fans are shut down.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Manual Smoke Pressuriz. System</td>
<td>With Fire Alarm System in alarm, utilizing control panel in Fireman Control Center, select a floor and place floor into purge mode.</td>
<td>Verify that Single Fan operates, Isolation dampers open only on selected Fans, Return Fans are off, Outside Air Handling Units are off, OSA dampers open, and return air dampers close.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Minimum OSA Unit Fan Off</td>
<td>Command AHU-1&amp;2 System off.</td>
<td>Verify that AHU ___ isolation dampers are closed, and if OSA temperature is above ____ Deg. F, heating coil control valve is closed.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Minimum OSA Unit Fan Off</td>
<td>Simulate a OSA temperature below 35 Deg. F.</td>
<td>Verify that heating coil control valve opens.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Minimum OSA Unit Temp. Control</td>
<td>Utilizing BAS software, reset discharge air setpoint to 80 Deg. F.</td>
<td>Verify that Face and Bypass Dampers and Heating Coil Control Valves modulate in sequence to maintain ____ Deg. F. Setpoint.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Minimum OSA Unit Freeze Condition</td>
<td>Simulate a condition at low limit detection thermostat of below 40 Deg. F.</td>
<td>Verify that BAS system goes into alarm, AHU- ____ Fans Shut Down, AHU- ____ Isolation Dampers Close, and Heating Valve Opens.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>On-Floor Return Fan Operation</td>
<td>Place AHU-____ in normal operating mode.</td>
<td>Verify that RAF ____- ____ Start and Run.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Building Static Pressure</td>
<td>Trend log the supply fan speed, the relief fan speed, relief damper position and the building static pressure for 12 hrs at 20 min. intervals. During the trend, force, if necessary, Observe in the trends that the building static pressure is maintained within +/- 0.05” of setpoint without excessive hunting. Carefully examine during the extreme economizer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step¹</td>
<td>Mode²</td>
<td>Test Procedure³</td>
<td>Expected Response⁴</td>
<td>Pass</td>
</tr>
<tr>
<td>-------</td>
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<tr>
<td></td>
<td></td>
<td>the economizer damper to be full open and at minimum. Document these times.</td>
<td>damper positions. Observe that any relief dampers modulate as expected relative to relief fan operation and static pressure.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>AHU Filter Drop</td>
<td>Reset the Filter Differential Pressure to exceed the setting recommended by the filter manufacturer.</td>
<td>Verify that the BAS reports an alarm.</td>
<td></td>
</tr>
</tbody>
</table>
| 21    | Chilled Water Valve Closing Efficiency | 1. Utilizing BAS, place AHU Units in WARMUP Mode.  
2. Manually close isolation Valve in Chilled Water Supply to AHU Coil.  
3. Place thermometer in Chilled Water Return Piping adjacent to AHU. Record temp. at 1 min. intervals for 15 min.  
4. Manually open isolation Valve in Chilled Water Supply to AHU Coil.  
5. Repeat Step 3.  
6. Graph Results on Temperature-Time Basis. | Chilled Water Return Temperature should approach RAT. If significant divergence is noted, review specified performance requirements of Chilled Water Control Valves. |      |     |    |
| 22    | Supply Fan Isolation Damper | Utilizing BAS, Command AHU-1, SF-1 into the off position. | Verify that AHU-1, SF-1 Isolation Dampers Close. |      |     |    |
| 23    | Review | Review schedules, current setpoints and sequences with Specification Section 15___ and Control Drawings prepared by BAS Provider. | Submit approved differences to be incorporated into the Record Drawings. |      |     |    |

**Record Footnotes:**

¹Sequences of operation specified in Contract Documents (attached).
²Mode or function ID being tested from testing requirements of the Contract Documents.
³Step-by-step procedures for manual testing, trend logging, or data-logger monitoring.
⁴Include tolerances for a passing condition.
⁵Record any permanently changed parameter values and submit to Owner.

8. Comments:
Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Commissioning Deficiency Report.

General Contractor:

Print Name: 
Signature:  
Title:  
Date:  

Mechanical Subcontractor:

Print Name:  
Signature:  
Title:  
Date:  

Other Subcontractor:

Print Name:  
Signature:  
Title:  
Date:  

Functional Performance Test procedure received and reviewed for completeness by MD ANDERSON representatives. Integrated System Test can proceed.

MD ANDERSON:

Print Name:  
Signature:  
Title:  
Date:  

MD ANDERSON:

Print Name:  
Signature:  
Title:  
Date:  

The University of Texas  ATTACHMENT “B” TO HVAC/PLUMBING/FIRE SUPPRESSION
MD Anderson Cancer Center  SYSTEMS FUNCTIONAL PERFORMANCE TESTS
MS052616  20 08 16 B
9 OF 9
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install pipe, fittings, valves, connections, hangers, supports, sleeves and appurtenances for new, rework and/or expansion of existing wet combination sprinkler and standpipe systems with supplementary items necessary for complete, code compliant and approved installation.

B. Contractor shall include within his bid all materials and Work to provide standpipe and 100% sprinkler protection for all areas in new construction or for the entire smoke compartment affected by renovation work.

C. Size all branches and mains by hydraulic calculations. Contractor shall conduct a water flow test to obtain water supply information to determine actual available volume and pressures as a design basis for the system, including storage tank replenishment on new systems. Provide a 10 psi cushion for all hydraulic designs. This Contractor shall verify that the affected existing systems are configured and functioning properly according to NFPA 13. Hazard classifications for fire protection system design, installation and water supplies shall be in accordance with NFPA Standards. EXCEPTION: All pipe sizes and water flow demand for Light Hazard Occupancies shall be based upon Ordinary Hazard (Group 1) as the minimum system design. Sprinkler head locations and spacing for Light Hazard Occupancies shall be in accordance with NFPA 13 requirements.

D. Interface all new flow and valve supervisory switches with building fire and smoke alarm systems.

E. Provide temporary fire protection during the construction phase of Project. Inform and obtain approval from the Owner and General Contractor for any interruptions of existing fire protection, domestic water or fire alarm systems. Adhere to ADM1131 Facilities Planned Utility Outages Policy for outage and shutdown requests.

F. The Environmental Health and Safety Department (EH&S) of UT MD ANDERSON is the Local Authority Having Jurisdiction (AHJ) for fire protection system equipment, materials, installation and applicable code interpretations.

1.03 REFERENCE STANDARDS

A. All materials, installation and workmanship shall comply with the applicable requirements and standards identified in Element Z2005 of UTMD Anderson Owner Design Guidelines.
1.04 QUALITY ASSURANCE

A. Standpipe and sprinkler system design, testing; cleaning, certification, materials, equipment and installation shall meet the requirements of standards identified in Element Z2005 of UTMD Anderson Owner Design Guidelines.

B. Obtain and become familiar with requirements of Owner's insurance underwriter and incorporate all applicable provisions for compliance.

C. Thoroughly and clearly document all Project related communications with code and regulatory agents and expediently forward communication documentation to the MD ANDERSON Project Manager.

D. Equipment and components shall bear FM label or UL marking. Provide manufacturer's name and pressure rating marked on valve body.

E. All hose threads, coupling types, etc., utilized in the fire protection systems shall conform to the standards and requirements of the City of Houston, Texas Fire Department.

F. Maintain at least one copy of all system related documents on Site.

G. Design sprinkler system under direct supervision of a R.M.E.'s (Responsible Managing Employee) experienced in design of this Work and licensed in the State of Texas. All design submittal documents and Shop Drawings shall bear the R.M.E.’s signed and dated registrations number. The system shall be installed by a firm having minimum three years experience regularly engaged in the design and installation of automatic fire protection systems in accordance with requirements of the National Fire Protection Association and the State of Texas Fire Marshal’s office. Evidence to support the above requirements shall be submitted with Shop Drawings. Working plans, material submittals and hydraulic calculations shall be reviewed by a fire protection engineering firm chosen by the owner for compliance with project specification and all applicable codes identified in Element Z2005 of UTMD Anderson Owner Design Guidelines. UTMD Anderson shall receive a report from the fire protection engineering firm identifying any discrepancies. If working drawings, material submittals and hydraulic calculations meet all applicable codes as identified in Element Z2005 of UTMD Anderson Owner Design Guidelines, the fire protection engineering firm shall submit a letter of approval to UTMD Anderson project manager and UTMD Anderson’s Fire and Life Safety group for final approval. NO WORK shall begin until UTMD Anderson project manager and UTMD Anderson Fire & Life Safety group grant final approval. The Contractor is solely liable for any and all work performed or material purchases made prior to UTMD Anderson final approval.

1.05 SUBMITTALS

A. General:

1. All new applications, all rework applications, and all modifications to existing systems shall be submitted for approval as described herein.

2. Product data shall be submitted for all size Projects as described herein.

B. Product Data:
1. Provide data on sprinkler heads, piping materials, joining methods, supports, valves, flow switches, tamper switches and all other components and accessories intended to be installed. Include manufacturers’ catalog information, Code and Standards compliance, performance ratings, rough-in details, weights, finishes, support and connection requirements.

2. Submit one of each style of sprinkler head proposed.

C. Record Documents:

1. Submit preliminary layout showing head locations within coordinated ceiling grid and inspector’s test station locations for review by Architect/Engineer, MD Anderson Project Manager, EH&S and owner designated fire protection engineering firm.

2. Submit verification of Contractor’s design and installation qualifications.

3. Provide full written description of manufacturer’s warranty.

4. Provide certificate of compliance from authority having jurisdiction indicating approval of field acceptance tests. Refer to paragraph 3.04 B, within this specification section.

5. Shop Drawings:

   a. Submit detailed and accurate Shop Drawings electronically of entire systems prior to fabrication. Indicate system controls, hydraulic reference points, detailed pipe layout, valves, hangers and supports, components and accessories.

   b. Hydraulic calculations: Submit flow test results and comprehensive hydraulic data sheets complying with NFPA 13. Verification of the adequacy of water pressure and other pertinent water supply data shall be the responsibility of the design engineer.

   c. Where expanding existing systems, the submitted design drawings shall show a sufficient amount of the existing system as required, the minimum shall show back to cross main or feed main to clearly identifying how the new work connects to the existing system.

6. As-Built Drawings and Closeout Documentation:

   a. All electronic Record Drawings must meet requirements of Section 01 78 39 – Project Record Documents.

   b. Provide three sets of Record Drawings electronically indicating actual installed locations, sizes and types of sprinkler heads, piping, valves, supports, equipment and all other system components. Identify all deviations from approved submittal drawings.

   c. Provide two sets of final hydraulic calculations.

   d. Submit certification letter by engineer of record stating that the fire protection systems design complies with Referenced Standards.

   e. Submit verification of Contractor’s design and installation qualifications.

   f. Provide full written description of manufacturer’s warranty.
g. Provide certificate of compliance from authority having jurisdiction indicating approval of field acceptance tests. Refer to paragraph 3.04 B, within this specification section.

h. Provide all written exception and authorizations for deviations from this specification.

D. Operation and Maintenance Data:

1. Include components of system, servicing requirements, inspection data, replacement part numbers, location and numbers of service depot. Provide a preventive maintenance schedule for all applicable equipment and systems.

1.06 DELIVERY, STORAGE AND HANDLING

A. All materials shall be new, undamaged, and free of rust. Protect installed piping, valves and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc.

B. Accept valves on-site in shipping containers and maintain in place until installation. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.

C. Protect all materials that are to be installed within this Project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.

1.07 EXTRA MATERIALS

A. Refer to Section 01 78 46 for Maintenance Materials requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All piping, materials and equipment used in the installation of sprinkler and standpipe systems shall be new and listed as approved by the Underwriters’ Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials and the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard and shall be the latest design of the manufacturer.

C. Pressure ratings of pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the designed system pressures in which they are installed.

D. The installing Contractor shall identify piping, fire department connections, valves and hydraulic design information in accordance with applicable NFPA Standards.

2.02 MANUFACTURER

A. Sprinkler Heads: Reliable, Grinnell, Viking, Flexhead.

E. Butterfly Valves: Milwaukee, Nibco, Grinnell, Victaulic, Kennedy.
F. Ball Valves: Milwaukee, Nibco, Stockham, Victaulic.
H. Grooved Fittings and Couplings: Grinnell, Anvil, Victaulic.
K. Electric or Water Motor Alarm Bells: Potter-Roemer, Reliable, Victaulic, Grinnell, and Viking.
L. In-Building Water Supply Riser: Ames.

2.03 SPRINKLER HEADS

A. Unless otherwise specified or indicated on the drawings, sprinkler heads shall be regular automatic closed type spray heads with temperature ratings as required by National Fire Protection Association Standard No. 13.

1. Heads within smoke compartments containing patient sleeping rooms shall be quick-response type.

2. The installing contractor is to verify the existing type of sprinkler head installed in area of renovation projects to ensure the response type is the same. Standard response and quick heads are not to be mixed in a project.

3. Finished Ceilings: Provide concealed ceiling sprinklers with factory finished (no field painting) cover plate, color to match ceiling finish. [Exception: Provide chrome plated or alternate color cover plates where directed by Architect].

4. Unfinished Areas without Ceilings: Provide bronze upright. Protect sprinkler heads against mechanical injury with standard guards where required.

5. Cold Rooms (≤ 42°F.) and Areas below Heated Ceiling/Soffit Spaces Susceptible to Freezing: Provide dry pendant type with chrome finish and two-piece escutcheon. (Areas include but not limited to; walk-in freezers, exterior overhangs, canopies…).


7. MRI Rooms: Provide non-ferrous semi-recessed chrome plated head and escutcheon.

8. Animal Vivarium’s: Provide recessed heads with gasket covers.

2.04 PIPING MATERIALS

A. Buried Water Service Entrance Piping

1. Pipe - Cement mortar lined ductile iron
2. Fittings – Cement mortar lined ductile iron using mechanical joints

3. Optionally, where building structural components permit, water service entrance may be composed of a single extended 90 degree fitting of fabricated 304 stainless steel tubing, maximum Working pressure of 175 psi with grooved-end connection on the outlet (building) side and a cast iron pipe size coupler on the underground (inlet) side.

4. All pipe and fittings shall be encased with polyethylene film having a minimum thickness of 8 mils.

B. Unburied Piping

1. All pipe and fittings shall be provided with Microbiological Inhibiting Coating (MIC).

2. Pipe
   a. Interior pipe not subject to freezing shall be Schedule 40 (minimum thickness) black steel.
   
   b. Exterior pipe including pipe installed within parking garages shall be Schedule 40 (minimum thickness) galvanized steel.

   c. Interior pipe subject to freezing shall be Schedule 40 (minimum thickness) galvanized steel.

   d. Exception: Pipe within MRI rooms and MRI room ceiling space shall be Type “K” hard drawn copper.

3. Fittings
   a. Fittings shall be threaded malleable or cast iron, flanged cast iron, welded steel or grooved ductile iron with gaskets and mechanical fasteners.

   b. Exceptions:
      
      1) All fittings within MRI rooms and MRI room ceiling spaces shall be wrought copper or bronze pressure and brazed joints.

      2) The use of grooved type fittings on pipe size 2 ½” and smaller in diameter is not allowed.

      3) FlexHead: Flexible fire sprinkler hose with threaded end fittings are acceptable.

   c. Groove-less clamp or saddle type fittings shall not be used without specific written authorization from the EH&S program manager for fire & life Safety. The use of galvanize fittings on black steel piping is not acceptable. The use of non-galvanize fittings on galvanize piping is not acceptable.

   d. All grooved joint couplings, fittings and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacture as the grooved components.
2.05 VALVES

A. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.

B. All valves used to control the flow of water to and within standpipe and sprinkler systems shall be listed indicating type complete with electric supervisory switches. Coordinate wiring with the electrical Contractor.

C. Hose valves shall have bronze finish; 2-1/2" hose thread connections with cast brass pin lug cap and chain.

D. All 1-1/2" hose valves shall be provided with adjustable regulators where required to limit static and residual pressures to 100 psi. All 2-1/2" hose valves shall be provided with adjustable regulators where required to limit static and residual pressures to 175 psi. 2-1/2" hose valves shall be initially set for an outlet pressure of between 125 to 150 psi where allowed by system design.

2.06 FIRE VALVE CABINETS

A. Provided within Architectural Division 10 of these Specifications.

B. Coordinate with General Contractor prior to ordering hose valves for compatibility assurance.

2.07 FIRE DEPARTMENT SIAMESE CONNECTIONS

A. Fire department connections shall have quantity of 2-1/2" hose thread connections as required by system capacity and be complete with cast brass pin lug caps and chains. Finish shall be determined by Architect. Connections shall be identified as required by NFPA 14.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable requirements and standards identified in Element Z2005 of UTMD Anderson Owner Design Guidelines.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install all materials and products in accordance with manufacturer’s published recommendations. Use tools manufactured for the installation of the specific material or product.

D. Sprinkler heads shall be located in a symmetrical pattern related to ceiling features such as grid, beams, light fixtures, diffusers, etc. and where applicable, heads shall be located symmetrically with the ceiling grid, centered in two directions. Locate heads to provide code required distances away from lights, exit signs, etc., and all other items that could interfere or effect sprinkler discharge.

E. Cover plates for concealed sprinklers are not to be installed until a field inspection is performed by Environmental Health and Safety to ensure the sprinkler heads are installed at the correct elevation within the ceiling tile as per manufacture product data sheets. The General Contractor on the project is responsible to coordinate this inspection through the MDA Project Manager. The project is to maintain, a copy of the manufacture product data sheet on the jobsite for this inspection.
F. Apply temporary protective covers during construction to ensure that sprinkler heads and escutcheons do not receive field paint.

G. Install fire sprinkler head cages/guards to sprinkler heads to protect heads susceptible to mechanical injury and to reduce the possible of accidental discharge (i.e. mechanical rooms, elevator shafts/pits, etc.).

H. Inspector’s test valves shall be installed for each sprinkler control valve assembly equipped with a flow switch and piped to a stairwell drain test riser within the building. When used in combination with the drain and test riser requirements for testing standpipes equipped with pressure-regulating hose valves, the drain test riser size shall be a minimum size of 3 inches. Provide a 2-½” female test connection with cap on each floor of the 3” test riser with pressure reducing hose valves. Each drain test riser discharge shall be piped to the exterior of the building. The exterior discharge point shall not discharge on a sidewalk, driveway or any other area that could result in staining, water accumulation or soil erosion. When exterior piping is not feasible, the drain test riser shall be piped to a suitable drain having sufficient capacity to accept full flow of pressure-regulating hose valves. When a project cannot meet this requirement, an alternative plan must be submitted for approval by the Project Management team and Environmental Health and Safety, before installation of fire protection system.

I. Auxiliary drains shall be installed on all sprinkler systems that do not allow complete drainage from the main drain. Any low point areas of a sprinkler system shall have a means of drainage either towards the main drain or auxiliary drain to eliminate any trapped water in the system.

J. Provide hangers for horizontal piping at intervals not exceeding twelve feet for pipe sizes 1-1/4” and smaller or fifteen feet for pipe sizes 1-1/2” and larger, and as recommended within NFPA.

K. Route piping in orderly manner, plumb and parallel to building structure and concealed above ceilings where possible. Locate concealed valves, switches and alarm connections in accessible location, and coordinate size and location of access panels/doors with General Contractor.

L. Install piping to conserve building space and not interfere with use of space and other work. Coordinate with other trades to avoid conflicts and provide all required offsets, piping, auxiliary drains, etc. to properly install system.

M. Group piping whenever practical at common elevations.

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

O. Flange and coupling bolts shall be torque in sequence per manufacturer specifications.

P. Pipe joints, clamps, groove couplings, flanges, unions, etc., shall not directly contact or be encased in concrete, or be located within wall, floor or roof penetrations.

Q. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

R. Provide an approved splash block at the point of drain or system test discharge outside of the building, where the ground may be disturbed by the flow of water.
S. Prepare pipe, fittings, supports and accessories for finish painting where required.

T. Provide thrust blocking and clamps for mechanical joint or gasketed underground water pipe at fittings with 3/4" rods and properly anchor and support.

U. Do not penetrate building structural members unless indicated otherwise on Contract Drawings.

V. Each pipe projecting through roof shall be installed in accordance with Contract Specifications and Drawings. Penetrations shall be sealed air and water tight. Refer to details on Contract Drawings and coordinate with General Contractor for flashing requirements.

W. Penetrations through fire rated walls, floors and partitions shall be sealed to provide a U.L. rating equal to or greater than the wall, floor or partition.

X. Seal all penetrations through exterior building walls and grade beams air and watertight.

Y. Install valves with stems upright, not inverted. All valves shall be located such that the removal of their bonnets is possible. Valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. Remove protective coatings after installation.

Z. Provide drain valves at main shutoff valves, low points of piping and apparatus.

AA. All shutoff and test valves shall be located on the floor they serve, unless specific written authorization is received from EH&S.

BB. Locate and secure hose cabinets plumb and level. Locate angle valve in cabinet at 60 inches above floor.

CC. Provide two-hour enclosure around all fire standpipe piping routed outside fire stairwell.

DD. 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 lying on the ground shall be removed. Flush entire system of foreign matter.

EE. Heat generated by welding or soldering procedures shall not be transmitted to valves, groove couplings, or any other components installed within the piping system that may be damaged due to high temperatures. Contractor shall take all precautions necessary and allow heated piping to cool to ambient temperature before attachment.

FF. All screw joints shall be made with taper threads properly cut. Joints shall be made tight with Teflon tape or non-toxic joint compound 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 upended and hammered to remove all shavings and foreign material.

3.02 ELEVATOR SPRINKLER PROTECTION

A. Elevator fire protection shall comply with NFPA 13, NFPA 70, NFPA 72, and ANSI/ASME A17.1 or A17.3 as applicable.
B. When sprinklers are installed in elevator equipment rooms, the electrical power to the elevator controller must shut down prior to sprinkler activation. A heat detector shall activate an independently controlled shunt trip circuit breaker when the temperature in the machine room exceeds the setting of the heat detector. The detector shall have both a lower temperature rating and a higher sensitivity (lower Response Time Index) as compared to the sprinkler. Sprinkler heads shall be rated at 212°F and heat detectors shall be rated at 135°F. Heat detectors used to shut down elevator power prior to sprinkler operation shall be placed within two feet of each sprinkler head and connected to the fire alarm control panel.

C. Smoke detectors shall be provided to initiate phase one elevator recall, sending cars to the appropriate level prior to electrical power shut-down.

D. No sprinkler risers shall be permitted inside any hoist way. Sprinkler branch lines shall enter hoist ways only where a sprinkler is required.

3.03 WELDED PIPING

A. Welding of pipe/fittings in normally occupied buildings is prohibited. Offsite welding is acceptable. Should welding be required in a normally occupied building for connecting to an existing welded system, obtain written approval via MD Anderson’s Hot Work Procedure and comply with NFPA 51 B and MD ANDERSON Environmental Health and Safety requirements.

B. All welding materials, procedures, qualifications and records shall comply with applicable NFPA requirements.

3.04 SYSTEM TESTING AND FLUSHING

A. Testing, cleaning, flushing and inspection shall be done in accordance with NFPA requirements.

B. The installing Contractor shall complete and sign the appropriate Contractor’s Material and Test Certificates included within NFPA 13 and 14. Tests and signing of test certificates shall be witnessed by MD ANDERSON Environmental Health and Safety Department representative or designee.

3.05 ZONING

A. All flow switches and tamper switches shall relay their activation to each annunciator panel and the main fire alarm panel.

B. Sprinkler system zoning shall coincide with building smoke compartmentalization unless noted otherwise on Contract Drawings. As a minimum, each floor level shall be a separate zone.

3.06 TRAINING

A. Contractor shall provide for the service of a competent, trained and experienced agent to instruct and acquaint the Owner with the proper functioning, operation and maintenance of the fire protection systems and all installed components.
3.07 WARRANTY

A. The complete system shall be warranted in writing against defects in materials or Workmanship under normal use and service for a period of one year after date of Substantial Completion.

END OF SECTION 21 10 13
SECTION 22 10 00 – PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Provide materials and installation for complete first class plumbing systems, within and to five feet beyond building perimeter unless noted otherwise on Contract Drawings; Sanitary Waste and Vent Piping, Storm Drain Piping, Domestic Water Piping, Domestic Water Valves, Testing and other normal parts that make the systems operable, code compliant and acceptable to the authorities having jurisdiction.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:


2. NOTE: MD Anderson takes various exceptions to the International Plumbing Code and has adopted the more stringent requirements within the Uniform Plumbing Code. These exceptions are included within Project Specifications and/or Project Design Drawings.


4. NSF/ANSI 372 : Drinking Water System Components – Lead Content

1.04 QUALITY ASSURANCE

A. Manufacturer’s name and pressure rating shall be permanently marked on valve body.

B. The Contractor shall notify the manufacturer’s representative prior to installing any copper press fittings. The Contractor shall obtain the representative’s guidance in any unfamiliar installation procedures. The manufacturer's representative of copper press fittings shall conduct periodic inspections of the installation and shall report in writing to the Contractor and Owner of any observed deviations from manufacturer’s recommended installation practices.
C. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.

D. All grooved joint couplings, fittings, flanges, valves, and specialties of the same type shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as grooved components.

E. Installer Qualifications:

1. Company shall have minimum three years documented experience specializing in performing the work of this section.

2. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

3. All installers of copper press fittings shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted to Owner prior to any installation.

4. All installers of copper grooved fittings shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted to Owner prior to any installation.

1.05 SUBMITTALS

A. Product Data:

1. Code and Standards compliance, manufacturer's data for pipe, fittings, valves and all other products included within this specification section.

2. Grooved joint valves, couplings and fittings shall be specifically identified with the applicable style or series designation.

3. Manufacturer’s installation instructions.

B. Record Documents:

1. Record actual locations of valves, etc. and prepare valve charts.

2. Test reports and inspection certification for all systems listed herein.

3. Provide a certificate of completion detailing the domestic water system chlorination procedure and all laboratory test results.

4. Submit proposed location of access panels which vary from quantities or locations indicated on Contract Drawings.

5. Provide full written description of manufacturer’s warranty.

C. Operation and Maintenance Data:
1. Include components of system, servicing requirements, Record Drawings, inspection data, installation instructions, exploded assembly views, replacement part numbers and availability, location and contact numbers of service depot.

1.06 DELIVERY, STORAGE AND HANDLING

A. All materials shall be new, undamaged, and free of rust.

B. Accept valves on Site in shipping containers and maintain in place until installation.

C. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.

D. Provide temporary end caps and closures on pipe and fittings. Maintain in place until installation.

E. Protect installed piping, valves and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris and repair materials as work progresses and isolate parts of completed system from uncompleted parts.

F. Protect all materials that are to be installed within this project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.

1.07 EXTRA MATERIALS

A. Refer to Section 01 78 46 for Maintenance Material Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide materials as specified herein and indicated on Contract Drawings. All materials and work shall meet or exceed all applicable Federal and State requirements and conform to adopted codes and ordinances of authorities having jurisdiction.

C. Pressure ratings of pipe, fittings, couplings, valves, and all other appurtenances shall be suitable for the anticipated system pressures in which they are installed.

2.02 SANITARY WASTE AND VENT AND STORM DRAINAGE PIPING

A. Cast iron soil pipe and fittings with hubless connections using clamp type gasketed mechanical fasteners above ground and hub and spigot DWV pipe and fittings with neoprene compression gasket joints for all buried pipe. Cast iron soil pipe, fittings and hub gaskets shall be manufactured by Tyler Pipe or Charlotte Pipe and Foundry. All cast iron pipe and fittings shall be of the same manufacturer.

1. EXCEPTION: Unburied sanitary waste and vent pipe and fittings installed at the Houston Campus (North of Holcombe Boulevard), shall be epoxy coated hubless cast iron soil pipe and fittings manufactured by NewAge Casting.
B. Secondary (emergency overflow) roof drain piping that discharges onto face of exterior building wall shall be CPVC Type IV, manufactured in accordance with ASTM F 2618, with CPVC drainage pattern fittings meeting ASTM D 3311. Joining method for CPVC pipe and fittings shall be with CPVC solvent cement manufactured in accordance with ASTM F 493. CPVC pipe and fittings shall meet 25/50 flame/smoke requirement for use in return air plenums when tested to ASTM E 84. All pipe, fittings and cement shall be supplied together and warranted as a system, manufactured by Spears Manufacturing Company or Owner approved equal. EXCEPTION: Secondary roof drain piping that discharges at grade level shall be as specified within paragraphs 2.02 A and/or C.

C. Unburied primary storm drainage and sanitary waste and vent piping for sizes 4” and smaller may be seamless copper DWV tube with wrought copper or wrought copper alloy solder joint drainage pattern DWV fittings.

D. Indirect waste piping sizes 1-1/4” through 2” serving fixtures and equipment shall be seamless copper DWV tube with wrought copper or wrought copper alloy solder joint drainage pattern DWV fittings.

E. Indirect waste piping sizes 1” and smaller serving equipment shall be type "L" hard drawn copper pipe and wrought copper or cast copper alloy solder joint fittings using lead-free solder and non-corrosive flux. Elbows shall be long radius type. Tee fittings shall be combination wye with 45 degree elbow.

F. Cast iron soil pipe compression gaskets shall be monolithically molded from an elastomer meeting ASTM C 564 and shall be of same manufacturer as pipe and fittings.

G. Clamps for joining hubless cast iron pipe and fittings sizes 1-1/2” through 15” shall meet the performance criteria of FM 1680, have type 304 stainless steel jacket, ASTM C 564 neoprene gasket and type 305 stainless steel band screws designed to be installed with a pre-set torque wrench. Couplings shall be manufactured by Clamp-All, Inc. HI-TORQ 125 or Husky, Inc., Orangeshield SD 4000.

H. Hubless piping systems shall not be used in a directly buried, underground application. EXCEPTION: No-hub type fittings with clamp type coupling joints may be used below ground for pipe sizes up to 10” at connections to existing cast iron sewers provided couplings are cast iron with stainless steel bolts as manufactured by MG Piping Products.

I. Solder for copper piping shall be lead-free Tin/Copper/Silver/Nickle(optional) solder conforming to ASTM B32, Lucas Milhaupt Silvabrite 100 Lead-Free Solder or Harris Nick Lead-Free Solder. Use water soluble flux recommended by solder manufacturer and conforming to ASTM B813 and NSF 61, Lucas Milhaupt Silvabrite 100 Water Soluble Flux or Bridgit Water Soluble Paste Flux.

J. Lubricant for drainage cleanout plugs shall be Loctite Marine Grade Anti-Seize or approved equal by Bostik Chemical Group, or Dow Corning Corporation.

K. Double sanitary tee fittings shall be not be used as a drainage fitting.

L. Provide IAPMO figure one, IAPMO figure five or double wye and eighth bend fittings on vertical lines serving back-to-back fixture drains.

M. Double wye and eighth bend fittings shall not be installed in horizontal drain lines.
N. All P-traps for floor drains, floor sinks and hub drains shall be deep-seal type.

O. Provide DWV copper trap adaptors or threaded brass marvel rings to connect fixture waste outlet to service piping within walls. Galvanized nipples shall not be acceptable.

2.03 DOMESTIC WATER PIPING (INCLUDES COLD, HOT, SOFTENED WATER & ANIMAL WATERING)

A. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall be UL classified in accordance with ANSI / NSF-61 for hot and cold potable water service, and shall be certified to the low lead requirements of NSF-372. Manufacturer must provide written documentation of compliance.

B. All brass and bronze piping materials within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.

C. Unburied piping shall be type "L" hard drawn copper pipe and wrought copper or cast copper alloy solder joint fittings using lead-free solder and non-corrosive flux. Piping sizes 2-1/2" and larger may be type "L" hard drawn copper and wrought copper or cast copper alloy roll groove fittings Style 607 Quick Vic utilizing no-sweat coupling with NSF 61 and NSF 372 approved gasket for hot and cold water, and flange adaptor Style 641 assemblies as manufactured by Victaulic or Owner approved equal by Anvil.

1. Flaring of tube and fitting ends to IPS dimensions is not allowed.

2. Provide a phenolic flange washer with flange when the mating flange face is not a smooth, hard surface. Refer to manufacturer’s installation instructions for additional details.

D. Unburied piping sizes ½" through 4" installed within occupied buildings for modifying existing systems may utilize copper press fittings when the following conditions are met:

1. Written approval of the Owner’s Property Manager shall be obtained prior to bidding.

2. Fittings shall be installed in portions of systems having an operating pressure that will not exceed 200 p.s.i.g.

3. Fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22.

4. O-rings for copper press fittings shall be EPDM. Copper press fittings shall be rated at 200 psi working pressure and 250 degree working temperature.

5. Copper press fittings shall not be used at water supply stub-outs having threaded connections; such as fixture supply stops, flush valves, etc. Solder fittings shall be used at these and similar locations having screwed connections.

6. All copper press fittings, couplings and specialties shall be manufactured by Viega.

7. Installation tools shall be as recommended by the fittings manufacturer.
E. Solder for copper piping shall be lead-free Tin/Copper/Silver/Nickle(optional) solder conforming to ASTM B32, Lucas Milhaupt Silvabrite 100 Lead-Free Solder or Harris Nick Lead-Free Solder. Use water soluble flux recommended by solder manufacturer and conforming to ASTM B813 and NSF 61, Lucas Milhaupt Silvabrite 100 Water Soluble Flux or Bridgit Water Soluble Paste Flux.

F. Buried domestic water service entrance piping 4” and larger shall be cement mortar lined Class 53 ductile iron pipe and 350 psi working pressure ductile iron fittings using mechanical joints. All buried ductile iron pipe and fittings shall be encased in polyethylene per ANSI/AWWA Standard C105/A21.5, Method A. Minimum thickness of polyethylene shall be 8 mil.

G. Buried pressurized piping sizes 1” and smaller shall be type “K” soft copper. No joints shall be allowed below slab. Encase piping within ⅜” thick un-slit flexible tube type elastomeric thermal insulation up to 1” above slab at both ends. Insulation shall be AP/Armaflex or Rubatex Insul-Tube 180.

H. Unburied trap primer piping shall be same as specified for domestic water except all elbows shall be long radius type.

I. Buried trap primer piping shall be type “K” soft copper. No joints shall be allowed below slab except at connection to drain. Encase piping within ⅜” thick un-slit flexible tube type elastomeric thermal insulation up 1” above slab. Insulation shall be AP/Armaflex or Rubatex Insul-Tube 180.

J. Dielectric waterway fittings shall have a copper-silicon casting or a zinc electroplated steel pipe body with high temperature stabilized polyolefin polymer liner; manufactured by Victaulic, Style 647 or PPP, Inc. Series 19000, or Owner approved equal by Anvil.

K. Dielectric unions shall be rated at 250 psi, ground-joint type with inert, non-corrosive thermoplastic sleeve. End connection materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc or Watts. Provide models to suit applicable transitions.

L. Dielectric flanges shall be rated at 175 psi, have nylon bolt isolators and dielectric gasket. Materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc or Watts. Provide models to suit applicable transitions.

M. Pipe joint compound shall be lead-free, non-toxic, non-hardening and compliant with ANSI/NSF 61 and Federal Specification TT-S-1732. Temperature service range of -15°F to +400°F, manufactured by Hercules “MegaLoc” or approved equal by Rectorseal, La-Co or Oatey.

N. All exterior water piping sizes 2” and smaller installed above grade shall be provided with electric heat in the form of 120 volt, single phased tape rated at 5 watts per lineal foot at 50°F. Heat tracing shall be manufactured for freeze protection service and be self-regulating to energize at 50°F. Provide an accessible temperature sensing thermostat between electrical power supply and connections to heat tracing to prevent power from activating tracing unless outside ambient temperature is at or below 40°F. This Contractor shall coordinate with the electrical Contractor to provide electrical power supply and connection. Heat tracing shall be by Raychem XL-TRACE or Thermon FLX. Thermostats shall be Raychem AMC-F5 or Thermon N4X-40.
2.04 DOMESTIC WATER VALVES: (INCLUDES COLD, HOT, SOFTENED WATER & ANIMAL WATERING)

A. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacturer, etc.

B. Line Shut-Off Valves up to and including 2” shall be two-piece bronze body of ASTM B584 Alloy 844, ASTM B61, or ASTM B62, full port ball type rated at 600 WOG with threaded connections, blow-out proof stem, plastic coated lockable lever handle, Teflon packing, 316 stainless steel ball and stem. Acceptable valves are NIBCO Model T-585-66-LF, or approved equivalent model by Crane, Milwaukee or Apollo.

C. Line Shut-Off Valves 2-1/2” and larger where system operating pressure will not exceed 160 p.s.i.g. shall be 200 WOG threaded lug type ductile iron body butterfly valve with extended neck, lockable lever handle, 416 stainless steel stem, aluminum bronze disc, EPDM liner and seal, suitable for bi-directional flow and dead end service with downstream flange removed. Acceptable valves are NIBCO Model LD-2000, or approved equivalent model by Keystone, Jamesbury, Milwaukee, Crane or Apollo.

D. Line Shut-Off Valves 2-1/2” and larger installed within systems having design operating pressures between 160 and 250 p.s.i.g. shall be threaded lug type ductile iron body butterfly valve with extended neck, lockable lever handle, 316 stainless steel stem and disc, EPDM liner and seal, suitable for bi-directional flow and dead end service with downstream flange removed. Acceptable valves are NIBCO Model LD-3022, or approved equivalent model by Keystone, Jamesbury, Dezurik, Milwaukee, Crane or Apollo.

E. Line Shut-Off Valves 2-1/2” and larger installed in roll grooved copper systems may be 300 psi roll grooved end type bronze body butterfly valve with lockable lever handle, aluminum bronze disc, with pressure responsive Grade CHP Fluoroelastomer seat, stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating, suitable for bi-directional flow and dead end service. Manufactured by Victaulic Series 608N or Anvil Model B680.

F. Provide stem extensions of a non-thermal conducting material for valves in insulated lines to allow unobstructed operation.

G. Provide memory stops on all ball valves installed in domestic hot water return lines. Memory stops shall be adjustable after pipe insulation is applied.

H. Provide line shut-off valves that have the same inside diameter of the upstream pipe in which they are installed.
I. Domestic Hot Water Return Circuit Balancing Valves 1/2" through 3" shall be machined ball type calibrated balancing valve with lead free ASTM B283-C69300 Brass body/304 Stainless Steel ball construction, glass and carbon filled TFE seat rings, EPDM stem "O" ring, threaded NPT inlet/outlet connections, 400 psig maximum working pressure at 250ºF. Valve shall have differential pressure read-out ports across valve seat area fitted with internal EPT inserts/check valves. Valve body shall have 1/4" NPT tapped drain/purge port. Valve shall have calibrated nameplate and memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. Valve shall contain less than 0.25% lead content by weight on wetted surfaces and be designed for positive shut-off. Valves shall be same size as the pipe installed. Provide valves as scheduled on Contract Drawings manufactured by Bell & Gossett Circuit Setter Plus CB series, or Owner approved equal.

J. Swing Check Valves, 2" and smaller - "Y" pattern bronze, Class 125, with threaded connections and screw-in cap. Manufactured by NIBCO Model T-413-Y-LF or approved equivalent model by Milwaukee or Crane.

K. Spring Loaded Check Valves, 2" and smaller - Silent closing, bronze, Class 125, with threaded connections, Buna disc, bronze or stainless steel spring. Manufactured by NIBCO Model T-480-LF or approved equivalent model by Milwaukee or Crane.

L. Swing Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-918-B-LF or approved equivalent model by Milwaukee or Crane.

M. Swing Check Valves, 2-1/2" and larger - 285 pound CWP, Iron body, with stainless steel trim. Manufactured by NIBCO Model F-938-33-LF or approved equivalent model by Milwaukee or Crane.

N. Spring Loaded Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-910-LF or approved equivalent model by Milwaukee or Crane.

O. Spring Loaded Check Valves, 2-1/2" and larger - 400 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-960-LF or approved equivalent model by Milwaukee or Crane.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry and not over-excavated. Do not install underground piping when bedding is wet or frozen.

B. Before commencing work, check final grade and pipe invert elevations required for drain terminations and connections to ensure proper slope.

3.02 PREPARATION

A. Ream pipes and tubes. Remove burrs, scale and dirt, inside and outside, before assembly. Remove foreign material from piping.
B. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. General

1. Care shall be exercised to avoid all cross connections and to construct the plumbing systems in a manner which eliminates the possibility of water contamination.

2. Install all materials and products in accordance with manufacturer’s published recommendations. Use tools manufactured for the installation of the specific material or product.

3. Wipe all paste residue and excess solder from all solder joints.

4. Heat generated by soldering procedures shall not be transmitted to valves, copper alloy roll groove fittings, copper press fittings, no-hub clamps, or any other components installed within the piping system that may be damaged due to high temperatures. Contractor shall take all precautions necessary, including utilizing wet wrapping or allowing heated piping to cool to ambient temperature before attachment.

5. Pipe joints, no-hub clamps, flanges, unions, etc., shall not directly contact or be encased in concrete.

6. Route piping in direct orderly manner and maintain proper grades. Installation shall conserve headroom and interfere as little as possible with use of spaces. Route exposed piping parallel to walls. Group piping whenever practical at common elevations.

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

8. Furnish all supports required by the piping included in this specification section.

9. Penetrations through fire rated walls, floors and partitions shall be sealed to provide a U.L. rating equal to or greater than the wall, floor or partition.

10. Seal all penetrations through floors, exterior building walls and grade beams air and water tight.

11. Each plumbing pipe projecting through roof shall be installed in accordance with Contract Specifications and Drawings. Penetrations shall be sealed air and water tight. Refer to details on Contract Drawings and coordinate with General Contractor for flashing requirements.

12. Furnish and install all necessary valves, traps, gauges, strainers, unions, etc. for each piece of equipment (including Owner furnished equipment) having plumbing connections, to facilitate proper functioning, servicing and compliance with code.
13. Provide code-approved transition adaptors when joining dissimilar piping materials. Adaptors installed shall be manufactured specifically for the particular transition.

14. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.

15. Close nipples shall not be installed in plumbing piping systems.

16. Bury outside water and drainage pipe minimum one foot below recorded frost depth.

17. Buried piping shall be supported throughout its entire length.

18. All excavation required for plumbing work is the responsibility of the plumbing Contractor and shall be done in accordance with Contract Documents.

19. Piping shall be insulated in accordance with Contract Documents.

20. Provide clearance for installation of insulation and for access to valves, air vents, drains, unions, etc.

21. Provide dielectric isolation device where non-ferrous components connect to ferrous components. Devices shall be dielectric union, coupling or dielectric flange fitting.

22. All piping shall be isolated from building structures, including partition studs, to prevent transmission of vibration and noise.

23. Isolate all bare copper pipe from ferrous building materials. “Tape is not an acceptable isolator.

D. Drainage and Vent Systems

1. Slope drainage lines uniformly at 1/4" per foot, for lines 3" and less, and 1/8" per foot for larger lines, unless noted otherwise on Contract Drawings. Maintain gradients through each joint of pipe and throughout system.

2. Buried pipe shall be laid on a smoothly graded, prepared subgrade soil foundation true to alignment and uniformly graded. Bell holes shall be hand-excavated so that the bottom of the pipe is in continuous contact with the surface of the prepared subgrade material. Piping invert shall form a true and straight line.

3. The size of drainage piping shall not be reduced in size in the direction of flow. Drainage and vent piping shall conform to the sizes indicated on the Contract Drawings. Waste lines from water closets shall not be smaller than four inches. Under no circumstances shall any drain or vent line below slab be smaller than two inches.

4. Unburied horizontal cast iron soil piping shall be supported at least at every other joint except that when the developed length between supports exceeds four feet, they shall be provided at each joint. Supports shall also be provided at each horizontal branch connection and at the base of each vertical rise. Supports shall be placed immediately adjacent to the joint. Suspended lines shall be braced to prevent horizontal movement. Unburied vertical cast iron soil piping rising through more than one floor level shall be supported with riser clamps at each floor level.
5. Install couplings for hubless pipe and fittings in accordance with manufacturer’s published recommendations. Use pre-set torque wrench and tighten band screws as required by manufacturer’s published instructions.

6. All unburied change of direction fittings within the roof drainage system shall be braced against thrust. Bracing shall incorporate galvanized steel pipe clamps and tie rods.

7. Provide cleanouts within sanitary waste systems at locations and with clearances as required by the code, at the base of each waste stack and at intervals not exceeding 75 feet in horizontal runs.

8. Provide cleanouts at the base of each vertical downspout and at intervals not exceeding 75 feet in horizontal building storm drain. Provide clearances as required by code. Horizontal roof drain piping located above building ground floor level will not require cleanouts.

9. A removable sink or lavatory p-trap with cleanout plug shall be considered as an approved cleanout for 2” diameter pipe.

10. All interior cleanouts shall be accessible from walls or floors. Provide wall cleanouts in lieu of floor cleanouts wherever possible. A floor cleanout shall be installed only where installation of a wall cleanout is not practical.

11. Provide a wall cleanout for each water closet or battery of water closets. Locate wall cleanouts above the flood level rim of the highest water closet but no more than twenty four inches above the finished floor.

12. Coordinate the location of all cleanouts with the architectural features of the building and obtain approval of locations from the Project Architect.

13. Lubricate cleanout plugs with anti-seize lubricant before installation. Prior to final completion, remove cleanout plugs, re-lubricate and reinstall using only enough force to provide a water and gas tight seal.

14. Install trap primer supply to floor drains, hub drains and floor sinks that are susceptible to trap seal evaporation and where indicated on Project Drawings. Primer unit installation shall comply with manufacturer’s published recommendations. Trap primer lines shall slope to drain at a minimum ¼” per foot.

15. Capped waste and vent connections for future extensions shall be located accessibly and not extend more than 24” from active main. Waste connections and vent connections shall be located at elevations that will allow future installation of properly sloped piping without the need to dismantle or relocate installed ductwork, piping, conduit, light fixtures, etc.

16. Unless indicated otherwise within Contract Documents, all sanitary vent pipes passing through the roof shall be provided with lead roof flashings constructed of 2-1/2 pound sheet lead with bases extending no less than ten inches on each side of the pipe. The vertical portion of the flashing shall extend upward the entire length of pipe and be turned tightly inside the pipe at least two inches and shall not reduce the inside diameter of vent pipe more than the thickness of the flashing. Lead flashings shall be furnished by Plumbing Contractor and turned over to Roofing Contractor for installation.
17. Locate all sanitary vent terminals a minimum of 25 feet horizontally from or 3 feet vertically above all air intakes, operable windows, doors and any other building openings.

18. Wastewater when discharged into the building drainage system shall be at a temperature not higher than 140°F. When higher temperatures exist, approved cooling methods shall be provided.

E. Domestic Water System

1. On each water supply line serving a plumbing fixture, item of equipment, or other device which has a water supply discharge outlet below the overflow rim, or where cross contamination may occur, provide and install an approved vacuum breaker or backflow preventer. Installation of vacuum breakers shall prevent any possible backflow through them.

2. Provide thrust blocking and clamps for mechanical joint or gasketed underground water pipe at fittings with 3/4" rods, and properly anchor and support. Restraining rods, clamps and hardware shall be thoroughly coated with bituminous material to prevent corrosion.

3. Copper piping shall be supported at no greater than six foot intervals for piping 1-1/2" and smaller and ten foot intervals for piping 2" and larger in diameter.

4. Install all water piping to allow all piping within the system to be drained at low points.

5. Air chambers, dead-legs, or any other piping arrangement that may allow water to stagnate shall not be installed within domestic water systems. Valves installed for future connections shall not extend more than 24" from an active main.

6. Provide manufactured water hammer arrestors in water supply lines as indicated on Contract Drawings and in accordance with Standard PDI-WH201.

7. Pipe insulation shall be applied over installed freeze protection heat tracing tape.

8. Install union type fitting downstream of isolation valves at equipment connections.

9. Solder joint fittings shall not be installed within 24" of a copper press fitting.

10. Identify piping utilizing copper press fittings in accordance with project specification section 20 05 53.

F. Domestic Water Valves

1. Domestic water shut-off valves shall be installed where shown on Drawings, at each fixture and piece of equipment, at each branch take-off from mains, at the base of each riser, and at each battery of fixtures.

2. Install shut-off valves in accessible locations. Provide access panels where valves would otherwise be inaccessible. Coordinate quantity, size and location requirements of access panels with General Contractor.

3. When altering or connecting to existing domestic water systems, verify that existing line shut-off valves provide positive isolation from the sections of piping serving areas outside of the Project Boundaries. Install new line shut-off valves where valves do not exist to provide positive isolation.
4. Install shut-off valves with stems upright or horizontal, not inverted.

5. Where threaded valves are installed in copper piping systems special care shall be taken to avoid damaging the valve or its parts due to overheating. Install copper or bronze male adaptors in each inlet of threaded valves. Sweat solder adaptors to pipe prior to connecting to valve body.

6. Provide spring loaded type check valves on discharge of water pumps.

7. Provide accessible check valves in the individual cold and hot water fixture supply lines serving mixing valve type faucets or assemblies having hose connection outlets that are not equipped with integral check stops.

8. Install a shut-off valve immediately upstream of each strainer

9. Install domestic hot water return circuit balancing valves where indicated on Contract Drawings and locate a minimum length of unrestricted straight pipe diameters downstream and upstream of all fittings and/or line shut-off valves as recommended by the valve manufacturer. Location of valves shall allow unobstructed access for monitoring and adjustment.

10. Adjust and set domestic hot water return circuit balancing valves to flows indicated on Contract Drawings and in accordance with valve manufacturer’s published instructions. Use flow meter recommended by valve manufacturer.

11. Provide a line shut-off valve, strainer, temperature gauge and union, upstream of each hot water return circuit balancing valve.

12. Provide check valve and isolation valve immediately downstream of each hot water return circuit balancing valve.

3.04 TESTING AND CLEANING

A. General

1. Equipment, material, power, and labor necessary for the cleaning, flushing, sterilization, inspection and testing of systems covered within this Specification Section shall be furnished by the Plumbing Contractor. All testing and inspection procedures shall be in accordance with Division 01 and Special Condition requirements of this Contract.

2. For any requested inspection, the Contractor shall complete prior inspections and tests to ensure that items are ready for inspection and acceptance by the Owner and/or Architect/Engineer. The Contractor shall be responsible for any and all costs incurred by Owner and/or Owner representatives, including consultants, resulting from a review or inspection that was scheduled prematurely.

3. The Contractor shall conduct the tests and the Owner’s Construction Inspector will witness and approve the results.

4. Verify systems are complete, flushed and clean prior to testing. Isolate all equipment subject to damage from test pressure. Test and inspect for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. Piping being tested shall not leak nor show any loss in test pressure for duration specified.
5. Leave piping uninsulated, uncovered and unconcealed until it has been tested and approved. Where any portion of piping system must be concealed before completion of entire system, the portion shall be tested separately as specified for the entire system prior to concealment. Contractor shall expose all untested covered or concealed piping.

6. In cases of minor installation and repairs where specified water and/or air test procedures are deemed impractical, Contractor shall obtain written approval from Owner’s Representative to perform alternate testing and inspection procedures. Alternate testing and inspection procedures for minor installation and repairs shall include visual evaluation of installed components by Owner’s Representative during a simulation of use.

7. The water utilized for tests shall be obtained from a potable source of supply.

8. Prepare testing reports. If testing is performed in segments, submit separate report for each segment, complete with diagram or clear description of applicable portion of piping. After inspection has been approved or portions thereof, certify in writing the time, date, name and title of the persons reviewing the test. This shall also include the description of what portion of the system has been approved. Obtain approval signature by Owner’s Representative. A complete record shall be maintained of all testing that has been approved, and shall be made available at the job Site. Upon completion of the work, all records and certifications approving testing requirements shall be submitted to the Owner’s Representative before final payment is made.

9. Gauges used for testing shall have increments as follows:
   a. Tests requiring a pressure of 10 psi or less shall utilize a testing gauge having increments of 0.10 psi or less.
   b. Tests requiring a pressure of greater than 10 psi but less than or equal to 100 psi shall utilize a testing gauge having increments of 1 psi or less.
   c. Tests requiring a pressure of greater than 100 psi shall utilize a testing gauge having increments of 2 psi or less.

10. Separately test above and below ground piping.

11. Do not introduce test water into piping systems when exposure to freezing temperatures is possible.

12. Do not introduce test water into sections of piping located above existing sensitive areas and/or equipment that may be damaged or contaminated by water leakage. Coordinate with Owner’s Representative to determine areas and/or equipment considered as being sensitive.

13. Defective work or material shall be reworked and replaced, and inspection and test repeated. Repairs shall be made with new materials. Pipe dope, caulking, tape, dresser couplings, etc., shall not be used to correct deficiencies.

14. The Contractor shall be responsible for cleaning up any leakage during flushing, testing, repairing and disinfecting to the original condition any building parts subjected to spills or leakage.

B. Drainage and Vent System
1. Testing:

a. Subject gravity drainage and vent piping and joints to a vertical water column pressure of at least ten feet. If after 12 hours the level of the water has been lowered by leakage, the leaks must be found and stopped and the water level shall again be raised to the level described and the test repeated until, after a 12 hour retention period, there shall be no perceptible lowering of the water level in the system being tested. This pressure shall be held for a test period of at least 15 minutes while being witnessed by the Owner's Representative.

1) Portions of drainage and vent piping located on uppermost level of building shall be subjected to a water column pressure created by filling the system to point of overflow at roof vent terminals and roof drains. The pipes for the level being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for 12 hours. This pressure shall be held for a test period of at least 15 minutes while being witnessed by the Owner's Representative.

b. Piping located above sensitive areas and/or equipment that may be damaged or become contaminated due to test water leakage shall be tested with air. Isolate the test section from all other sections and slowly fill pipe with oil-free air until there is a uniform gauge pressure of 5 pounds per square inch (34.5 kPa) or sufficient pressure to balance a 10-inch (254 mm) column of mercury. The air pressure shall be regulated to prevent the pressure inside the pipe from exceeding 5.0 PSIG. This pressure shall be held for a test period of at least 15 minutes. Any adjustments to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period. This pressure shall be held for a test period of at least 15 minutes while being witnessed by the Owner's Representative.

2. Test forced (pumped) drainage piping by plugging the end of the piping at the point of connection with the gravity drainage system and applying a pressure of 5psi (34.5 kPa) greater than the pump rating, and maintaining such pressure for 15 minutes while being witnessed by the Owner's Representative.

3. Should the completion of these tests leave any reasonable question of a doubt relative to the integrity of the installation, additional tests or measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of the Owner's Representative.

4. Test plugs must extend outside the end of pipe to provide a visible indication for removal after the test has been completed.

5. Cleaning and Flushing:

a. During the Plumbing Systems Functional Performance Tests, each floor drain p-trap that has successfully passed pressure testing shall be proven clean and free of debris as follows:

1) An inspection request shall be submitted to the Owner, identifying the quantity and location of drain(s) to be inspected.
2) Vacuum out each floor drain p-trap in the presence of the Owner’s Representative. A visual inspection of the trap shall be performed to verify that the trap is debris free.

3) Perform a free flowing test by pouring two five gallon buckets of water down the floor drain.

4) After the Owner’s Representative has confirmed that the floor drain trap is clean and free of debris, insure that the trap is filled with water.

5) Install Trap Guard if required.

6) At the discretion of the Owner’s Representative, a visual inspection of the trap utilizing a sewer scope may be required in addition to, or in lieu of, a vacuum procedure.

b. During the Plumbing Systems Functional Performance Tests, the Owner's Representative may require that any portion of the drainage, waste and vent systems installed under this Project Contract be proven undamaged, clean and free of debris. Verification of the interior condition of piping shall be accomplished utilizing a sewer scope or other method as determined by the Owner's Representative.

C. Domestic Water System

1. Testing:

   a. Subject piping system to a hydrostatic pressure of at least 125 pounds per square inch gauge, but not less than the operating pressure under which it is to be used, for a period of no less than 12 hours. During test period, all pipe, fittings and accessories in the particular piping system that is being tested shall be carefully inspected. If leaks are detected, such leaks shall be stopped and the hydrostatic test shall again be applied. This procedure shall be repeated until no leaks are detected for an entire 12 hour period. This pressure shall be held for a test period of at least 15 minutes while being witnessed by the Owner's Representative.

   b. EXCEPTION: Piping located above sensitive areas and/or equipment that may be damaged or become contaminated due to test water leakage shall be tested with oil-free air in lieu of water.

   c. All domestic hot water systems that include a secondary copper/silver disinfection system shall be balanced and background copper testing completed prior to activation. Background copper (CU) content shall be less than 0.30 PPM. Obtain acceptance of the background copper results from MD Anderson Cancer Center representatives prior to start-up and commissioning of the secondary copper/silver disinfection system.

2. Flushing, Cleaning and Disinfection:

   a. Where specified procedures are deemed impractical, Contractor shall obtain written approval from Owner’s Representative to perform alternate flushing, cleaning and/or disinfection procedures.
b. All active existing domestic water piping and plumbing fixtures within the Project Boundaries that will remain in service after completion of this Project shall be periodically flushed during the duration of the Project to insure potability and sanitation.

1) Operate all plumbing fixtures and equipment that is connected to the domestic water system twice each week on Monday and Friday as follows:

   a) Flush each water closet and urinal.

   b) Flush water outlets (hot & cold) for a minimum of three minutes on each lavatory, sink, shower, drinking fountain, hose bib, and all other connected fixtures/equipment.

c. All existing water piping within the Project Boundaries that will remain in service after completion of this Project and has been dormant for two weeks or longer shall be flushed and disinfected as required within this specification section.

d. A bacteria test is not necessary for small scale work. However, disinfection is required. Examples of small scale work are less than 20 feet of pipe, replacement and/or installation of a sink, drinking fountain, eyewash, backflow preventer, isolation valve, etc. Disinfect individual parts, fixtures, isolation valves, pipes, etc. by swabbing with full strength bleach (5.25%) or soaking for at least 30 minutes in a 500 ppm chlorine solution. The 500 ppm solution can be made by adding one part 5.25% bleach (household bleach) to 100 parts drinking water. For example 3-1/2 ounces of bleach can be added to 2-1/2 gallons drinking water. Materials should then be thoroughly rinsed before putting into service.

e. After completion of the testing, all new and/or altered water piping systems shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. Do not exceed 150 parts per million at any time. Introduce chlorine into the supply stream at a rate sufficient to provide a uniform concentration throughout the system. All outlets shall be opened and closed several times. When the specified level of chlorine is detected at every outlet in the system, close all valves to prevent release of water from the system for 24 hours. At the completion of the 24 hour disinfection period, test every outlet for a minimum chlorine residual of fifty parts per million. This minimum residual must be present to proceed with flushing. Flush the system with clean water at a sufficient velocity until the residual chlorine detected at every outlet is within 0.2 parts per million of the normal water supply's level.

f. Sufficient samples must be taken no sooner than 24 hours after sterilization and flushing to represent the extent and complexity of the affected water system, along with a control sample to indicate municipal water quality at the time of testing. Send water samples to an accredited laboratory to perform qualitative and quantitative bacteriological analysis in accordance with AWWA C651. Contractor shall obtain written certification from the independent testing agency stating that the water samples meet Federal and State guidelines for safe drinking water. Upon satisfactory completion of all procedures, and receipt of acceptable laboratory test results, obtain written approval by Owner's representative. Failure to fully comply with the above procedures will result in a requirement to repeat the procedure until acceptable results are achieved, at no additional cost to the Owner.
g. Isolate or bypass equipment that would be detrimentally affected by disinfecting solution. Isolate all other sections of the domestic water system not being disinfected to prevent migration of chlorine.

h. Prior to injection of chlorine into the piping system, strategically place signs stating “Heavily Chlorinated Water - Do Not Drink”, and protect all outlets to prevent use during disinfection and flushing procedures.

i. All domestic hot water systems that include a secondary copper/silver disinfection system shall be flushed as described within 3.04 C.2.b.1) for no less than 90 days prior to activation of the secondary copper/silver disinfection system. Maintain records of flushing procedure and submit to Owner for verification.

3.05 TRAINING

A. Obtain services of the copper press fitting manufacturer to provide on-site training for Contractor's field personnel in the use of pressing tools and installation of fittings. The manufactures representative shall periodically visit the jobsite and provide the contractor information concerning the best recommended practices in product installation. A distributor's sales representative is not considered qualified to conduct the training or jobsite visit(s).

B. Obtain services of the grooved copper fitting manufacturer to provide on-site training for Contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved end couplings. The manufactures representative shall periodically visit the jobsite and provide the contractor information concerning the best recommended practices in grooved product installation. A distributor's sales representative is not considered qualified to conduct the training or jobsite visit(s).

END OF SECTION 22 10 00
SECTION 22 10 30 – PLUMBING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Provide all materials and installation for plumbing specialties within building domestic water, sanitary waste and storm drainage systems; floor drains, floor sinks, hub drains, roof drains, cleanouts, backflow preventers, vacuum breakers, pressure regulating valves, water hammer arrestors, wall hydrants, hose bibbs, trap primer units, strainers, temperature gauges, pressure gauges and other normal parts that make the systems complete, operable, code compliant and acceptable to the authorities having jurisdiction.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:


2. NOTE: MD Anderson takes various exceptions to the International Plumbing Code and has adopted the more stringent requirements within the Uniform Plumbing Code. These exceptions are included within Project Specifications and/or Project Design Drawings.


1.04 QUALITY ASSURANCE

1. Manufacturer’s name and pressure rating shall be permanently marked on valve body.

2. All materials shall be new, undamaged, and free of rust. Protect installed products and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris as work progresses.

3. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.
4. Installer Qualifications: Company shall have minimum three years documented experience specializing in performing the work of this section. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

1.05 SUBMITTALS

A. Product Data:
   1. Provide Code and Standards compliance, component dimensions, service sizes and finishes.

B. Record Documents:
   1. Manufacturer’s certification documentation for backflow preventers.
   2. Submit proposed location of access panels which vary from quantities or locations indicated on Contract Drawings.
   3. Provide full written description of manufacturer’s warranty.
   4. Record actual locations of plumbing specialties installed.

C. Operation and Maintenance Data:
   1. Include testing procedures for backflow preventers, adjustment procedures for water pressure regulating valves.
   2. Include installation instructions, exploded assembly views, servicing requirements, installation instructions, spare parts lists, replacement part numbers and availability, location and contact numbers of service depot, for all plumbing specialties installed.

1.06 DELIVERY, STORAGE AND HANDLING

A. Accept specialties on site in shipping containers and maintain in place until installation.

B. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work and isolating parts of completed system.

D. Protect all materials before and after installation from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for installation within exterior environments.

1.07 EXTRA MATERIALS

A. Refer to Section 01 78 46 for Maintenance Material Requirements.
PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide plumbing specialties as indicated and scheduled on the Contract Drawings and as specified herein. All materials and work shall meet or exceed all applicable Federal and State requirements and conform to adopted codes and ordinances of authorities having jurisdiction.

C. Pressure and temperature ratings of plumbing specialties shall be suitable for the anticipated system pressures and temperatures in which they are installed.

D. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall be UL classified in accordance with ANSI / NSF-61 for hot and cold potable water service, and shall be certified to the low lead requirements of NSF-372. Manufacturer must provide written documentation of compliance.

E. All brass and bronze plumbing specialties within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.

F. Specialties of same type shall be product of one manufacturer.

2.02 ACCEPTABLE MANUFACTURERS

A. Floor Drains: Wade, Zurn, Smith, Josam.

B. Floor Sinks: Wade, Zurn, Smith, Josam.

C. Roof Drains: Wade, Zurn, Smith, Josam.

D. Wall/Floor Cleanouts: Wade, Zurn, Smith, Josam.

E. Backflow Preventers and Vacuum Breakers: Watts Regulator, Febco, Conbraco.

F. Water Pressure Regulating Valves: Wilkins, Watts Regulator, Cla-Val.


H. Wall Hydrants: Wade, Zurn, Smith, Josam.

I. Hose Bibbs: Chicago.

J. Trap Primer Units: As Specified Herein

K. Strainers: Conbraco, Wilkins, Watts

L. Temperature Gauges: Ashcroft, Trerice, Weksler

M. Pressure Gauges: Ashcroft, Trerice, Weksler
2.03 FLOOR DRAINS (FD)

A. All floor drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.

B. Each floor drain shall be provided with a deep-seal p-trap unless noted otherwise.

C. Floor drains installed for general floor area drainage within toilet rooms and other finished spaces shall have cast iron body with flange, adjustable top and sediment bucket, integral reversible clamping collar, seepage openings, 1/2” plugged primer tap, and 6” diameter nickel bronze or stainless steel strainer with vandal proof screws.

D. Floor drains installed for general floor area drainage and light to medium flow indirect equipment discharge within mechanical rooms shall have cast iron body with plugged 1/2" primer tap, integral clamping collar, seepage openings, adjustable top and 11-1/2” diameter ductile iron loose set tractor grate.

E. Floor drains installed for non-monolithic shower stall floors shall have cast iron body with flange, adjustable top, integral reversible clamping collar, seepage openings and 5” diameter nickel bronze or stainless steel strainer with vandal proof screws.

F. All floor drains shall be as sized and scheduled on Contract Drawings.

2.04 FLOOR SINKS (FS)

A. All floor sinks shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.

B. Each floor sink shall be provided with a deep-seal p-trap unless noted otherwise.

C. Floor sinks installed for general floor area drainage shall have 8” round cast iron body with 3” sump, acid resistant enamel interior, aluminum dome strainer, seepage flange, membrane clamping device and 7-3/8” diameter stainless steel or nickel bronze top.

D. Floor sinks installed to receive indirect equipment discharge shall have cast iron 12” square body with 8” sump, acid resistant enamel interior, aluminum dome strainer, seepage flange, membrane clamping device and stainless steel top. Top shall be ½ or ¾ grate as scheduled on Drawings.

E. All floor sinks shall be as sized and scheduled on Contract Drawings.

2.05 HUB DRAINS (HD)

A. Hub drains shall be cast iron soil pipe manufactured hubs or hub adapters. Field cut no-hub or plain-end pipe stub-ups are not acceptable.

B. Each hub drain shall be provided with a deep-seal p-trap.
2.06 ROOF DRAINS (RD)

A. Primary roof drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted and have lacquered cast iron body with sump, removable cast iron or bronze dome strainer, flashing flange and clamp, gravel stop, deck clamp and drain receiver. Provide extension where required.

B. Secondary (emergency overflow) roof drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted and have minimum 2” high water dam, acid resistant epoxy coated cast iron body and sump, removable bronze dome strainer, flashing flange and clamp, gravel stop, deck clamp and drain receiver. Provide extension where required.

C. Roof drains shall be sized as indicated on Contract Drawings.

2.07 CLEANOUTS:

A. Cleanouts shall be the same nominal size as the pipe they serve up to four inches.

B. Cleanouts shall have cast iron body with tapered cast brass or bronze plug providing gas and watertight seal.

C. Interior floor cleanouts shall have stainless steel or nickel bronze scoriated top. Provide carpet marker when installed in areas to be covered by carpet.

D. Exterior cleanouts at grade shall have scoriated cast iron top.

E. Wall cleanouts shall be provided with stainless steel access covers of adequate size to allow rodding of drainage system. Wall cleanouts incorporating cover screws that extend completely through the access plug are not acceptable.

2.08 BACKFLOW PREVENTERS (INCLUDES BACKPRESSURE AND BACKSIPHONAGE)

A. Reduced Pressure Zone Type (Not For Use In Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1013, AWWA C511.

2. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves and captured springs. Backsiphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel. The assembly shall include two tightly closing shutoff valves before and after the valve and test cocks.

3. Test cocks

4. Seats: Bronze, removable and replaceable without removing valve from the line.

5. Checks: Independently operating.

6. Relief Valve: Independently operating, located between the two check valves.

7. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 140°F.
8. Unit to be complete with vent-port funnel to maintain the air gap and to provide a drain connection point.

9. Sizes 1/4” and 1/2” - Bronze body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 009.

10. Sizes 3/4” through 2” - Bronze body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 909.

11. Sizes 2-1/2” through 10” - FDA epoxy coated cast iron body, FDA epoxy coated strainer, upstream and downstream OSY – UL/FM outside stem and yoke resilient seated gate valves, flange connections: Watts Regulator Company Series 909.

B. Reduced Pressure Zone Type (For Use In Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1013, be U.L. classified and FM Approved.

2. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves and captured springs. Backsiphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel. The assembly shall include two tightly closing shutoff valves before and after the valve and test cocks.

3. Test cocks

4. Replaceable seats

5. Checks: Independently operating.

6. Relief Valve: Independently operating, located between the two check valves.

7. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 110°F.

8. Unit to be complete with vent-port funnel to maintain the air gap and to provide a drain connection point.

9. Sizes 2-1/2” through 10” - Schedule 40 stainless steel body, upstream and downstream UL/FM outside stem and yoke resilient seated gate valves or UL/FM grooved gear operated butterfly valves with tamper switches: Watts Regulator Company Series 957.

C. Double Check Valve Assembly (Not for Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1015, AWWA C510

2. Top entry access points for each check assembly

3. Replaceable seats

4. Test cocks

5. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 140°F.
6. Sizes 1/2" through 2" - Bronze alloy body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 719.

7. Sizes 2-1/2" through 10" - FDA epoxy coated cast iron body, FDA epoxy coated strainer, upstream and downstream OSY – UL/FM outside stem and yoke resilient seated gate valves, flange connections: Watts Regulator Company Series 709.

D. Double Check Valve Assembly (For Use In Fire Protection Water Supply):

1. The assembly shall meet the requirements of ASSE 1015, be U.L. classified and FM Approved.

2. Two independent tri-link check modules within a single housing

3. Sleeve access port

4. Four test cocks

5. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 110°F.

6. Sizes 2-1/2" through 10" - Schedule 40 stainless steel body, upstream and downstream UL/FM outside stem and yoke resilient seated gate valves or UL/FM grooved gear operated butterfly valves with tamper switches: Watts Regulator Company Series 757.

E. Continuous Pressure Vacuum Breaker (Not For Use In Fire Protection Water Supply. Not to be used for backpressure protection):

1. Tested and certified under ASSE Standard 1056.

2. Suitable for continuous pressure hot and cold water.

3. Brass body and seat with silicon rubber discs.

4. Rated maximum pressure 150 psi and working temperature 33 to 180 degrees F.

5. Complete with quarter turn ball valves and test cocks.

6. Sizes 3/8" through 1" - Spill-resistant, Watts Regulator Company Series 008PCQT.

F. Dual Check Valves (For Use in Beverage Dispenser Water Supply):


2. Tested and certified under ASSE Standard 1022.

3. Atmospheric port

4. 316 stainless steel body

5. Rated maximum pressure 150 psi and working temperature 33 to 130 degrees F.

2.09 WATER PRESSURE REGULATING VALVES

A. Low to Moderate Flow Systems (Less Than 70 GPM) and Individual Equipment
   1. Sizes 1/2” through 2"
   2. All bronze body
   3. 0.25% maximum weighted average lead content
   4. Integral stainless steel strainer screen
   5. Built-in bypass check valve
   6. FDA approved elastomers
   7. Renewable seat
   8. Union end connection
   9. Rated for water temperature up to 180°F and minimum 300 psi inlet pressure. Provide model with inlet pressure rating, reduced pressure range and factory preset outlet pressure as scheduled on Contract Drawings.
   10. Manufactured by Wilkins Series 600XL or approved equal by Watts.

B. Large Demand Systems
   1. Sizes 1-1/4” through 2 - ASTM B62 bronze body
   2. Sizes 2-1/2” and larger - ASTM A536 ductile iron body
   3. Pressure reducing pilot control
   4. Stainless steel disc guide, seat and bearing cover
   5. Stainless steel stem, nut and spring
   6. FDA approved Nylon reinforced Buna-N rubber diaphragm
   7. Provide model(s) with size, temperature range, inlet pressure rating, reduced pressure range, outlet pressure and options as scheduled on Contract Drawings.
   8. Cla-Val Company Series 90 or approved equal by Watts.

2.10 WATER HAMMER ARRESTORS (SHOCK ABSORBERS):

A. Nesting type bellows operated water hammer arrestor with male N.P.T. connection. Bellows and body casing made of Type 304 stainless steel. Water hammer arrestors shall be certified to the PDI WH-201 Standard and ASSE Standard 1010.

B. Arrestors shall be designed and manufactured for a maximum working temperature of 250°F and maximum operating pressure of 125 P.S.I.G.
C. Water hammer arrestors shall be sized according to water hammer arrestors standard PDI-WH-201 and as indicated on Contract Drawings.

2.11 WALL HYDRANTS (WH)

A. Provide antisiphon, non-freeze wall hydrant with brass casing, integral backflow preventer, vandalproof box with loose-key handle and finish as scheduled on Drawings.

2.12 HOSE BIBBS (HB)

A. General Areas: Provide Chicago Faucet No. 387 chrome plated brass hose bibb with ¾-inch female inlet, wall flange, tee handle and No. E27 vacuum breaker.

B. Housekeeping Mop Sinks: Provide Chicago Faucet No. 293-369COLDPCP chrome plated brass hose bibb with ¾-inch female inlet, wall flange and lever handle.

2.13 FLOOR DRAIN TRAP PROTECTION INSERTS

A. Trap seal protection inserts shall only be installed where job conditions prevent the installation of water supplied trap primers.

1. Trap seal protection insert shall not be installed in drains receiving waste that may have a temperature greater than 140 degrees F.

2. Trap seal protection insert shall not be installed in drains receiving waste discharge flow of greater than 30 gallons per minute.

3. Trap seal protection insert shall not be installed in drains receiving corrosive or chemical waste.

B. Floor drain trap seal protection insert shall provide watertight seal inside the floor drain and prevent emission of sewer gas and backup of sewage.

C. Insert material shall be resistant to common cleaning solutions, lime scale and microbiological growth and incorporate a Elastomeric flexible tube that closes when water is not passing through and opens to permit water flow from an intermittent drip. Insert shall provide no restriction on water flow up to 30 gallons per minute.

D. Insert shall properly functions despite lodging of common debris such as mop strings, food residue, etc.

E. Trap seal protection insert shall be manufactured by ProSet "Trap Guard", model to suit installation.

2.14 WATER SUPPLIED TRAP PRIMER UNITS (TP)

A. Trap Priming devices that rely upon line pressure differential for activation are not allowed.

B. Electronic Trap Primers:

1. Provide model with quantity of outlets and type of mounting box as scheduled on Contract Drawings.
2. The number of traps served by a single trap priming device shall not exceed the number of header outlets provided within the device. Auxiliary distribution units are not allowed.

3. All unused header outlets shall be capped water-tight with compatible threaded fittings.

4. Each electronic trap primer device shall be provided with a readily serviceable strainer immediately upstream of the device solenoid valve.

5. Electronic trap primers shall provide 10 second water injection to traps every twenty-four hours, complete with galvanized steel box and cover, copper inlet connection, brass ball type stop valve, slow closing 24 VAC solenoid valve with integral strainer, 120-24 VAC transformer, brass atmospheric vacuum breaker, and copper waterway.

6. Electronic trap primers shall be manufactured by Zurn Z1020-CW or approved equal by Precision Plumbing Products “Prime Time”, model to suit installation.

C. Vacuum Breaker Trap Primer for use with exposed Flushometers:
   1. This type of device shall not serve more than one trap.
   2. One Piece, Chrome Plated Flush Connection.
   3. Water Deflector to control the amount of water diverted from the flush.
   4. 3/8" Elbow and Flex-bend Tube connection from Vacuum Breaker to wall.
   5. Diverter Wall Flange and Fittings
   6. Chrome Plated Wall Flange and Fitting to connect ½” NPT pipe.
   8. One-piece Bottom Hex Coupling Nut.
   9. Sloan Model VBF-72-A1

D. Trap Primer for use with Lavatory or Sink Drain Tailpiece:
   1. This type of device shall not serve more than one trap.
   2. Polished Chrome Plated Cast Bronze P-trap with Ground Joint Outlet.
   3. Threaded Wall Tube, Slip Joint Nuts, Washers and Escutcheons.
   4. 1/2" Polished Chrome Plated Bronze Primer Tube with Compression Fitting Connection at Wall.
   5. Jay R. Smith Model 2698 or approved equal of a referenced acceptable manufacture.

2.15 STRAINERS

A. Strainers, 2" and smaller, bronze body, screwed ends, No. 20 mesh type 304 stainless steel screen, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap).
B. Strainers, 2-1/2" and larger, Cast iron body, isolating type flanged ends where installed in copper lines, .125" perforated type 304 stainless steel screen, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap). Special Note: All strainers 6" and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6" and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.

2.16 TEMPERATURE GAUGES:

A. Thermometers shall be vapor or liquid actuated, direct-mounted, universal adjustable angle dial type with stainless steel or cured polyester powder coated cast aluminum case, stainless steel friction ring and glass window. Dial face shall be white with black figures; pointer shall be friction adjustable type. Movement shall be brass with bronze bushings. Bourdon tube shall be phosphor bronze with a brass socket.

B. Thermometer range shall be 30 - 240° Fahrenheit and have an accuracy of ±1 scale division.

C. Dial face shall be 4½” diameter where installed within eight feet of floor level and 6” diameter where installed higher than six feet above floor level. Provide remote read-out gauges for isolated or hard to access monitoring points.

D. Provide a brass or stainless steel separable thermowell for each thermometer.

E. Thermometers shall have a sensing bulb with an insertion length of roughly half of the pipe diameter; minimum insertion length shall be 2”. Thermometers installed on tanks shall have a minimum insertion length of 5”.

F. Where insulation thickness exceeds 2”, provide proper bulb length and an extension neck separable thermowell. The extension neck shall be at least 2” long.

2.17 PRESSURE GAUGES:

A. Gauges shall comply with ASME B40.1, Grade 2A, and have ±0.5 percent of full scale accuracy, with type 304 stainless steel or aluminum case, bronze wetted parts and brass socket. Dial face shall be 3½” diameter where installed within six feet of floor level and 6” diameter where installed higher than eight feet above floor level. Dial face shall be aluminum with white background, black graduations and black markings. Pointer shall be adjustable with black finish. Provide remote read-out gauges for isolated or hard to access monitoring points.

B. Units of measure shall be in pounds per square inch (psi). The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.

C. All pressure gauges shall be equipped with brass or stainless steel needle valves and pressure snubbers.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains with General Contractor.
3.02 INSTALLATION

A. General

1. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

2. Install plumbing specialties in accordance with manufacturer’s published instructions.

B. Drains and Cleanouts

1. Extreme care shall be used to set the top elevation of floor drains and floor sinks to meet the low point elevation of the finished floor.

2. Pipe connections to roof drains, above grade floor drains and floor sinks shall not directly contact or be encased in concrete.

3. Final mounting of interior cleanout top or access cover shall be set flush with the finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.

4. Encase exterior cleanouts within 14” x 14” x 6” thick reinforced concrete pad. Set top flush with finished grade surface.

5. Locate cleanouts with required clearance for rodding of drainage system.

C. Backflow Preventers and Vacuum Breakers

1. Isolate all non-potable water requirements from the building domestic water system with backflow prevention device manufactured and certified for the particular application.

2. Pipe relief from backflow preventer indirectly to drain of sufficient size to evacuate maximum flow discharge.

3. Backflow preventers shall be duplexed full-size where located within domestic water lines serving in-patient areas, critical research areas, and/or any area or equipment where uninterruptible (24 hour) water service is required.

4. Test ports shall not be located more than 72 inches above finished floor or permanent platform.

5. Do not install vacuum breakers or backflow preventers above equipment, above ceilings, concealed within walls, or areas where water leakage can cause damage.

6. Install a strainer immediately upstream of each vacuum breaker and backflow preventer.

D. Water Hammer Arrestors (Hydraulic Shock Absorbers)
1. Provide hydraulic shock absorbers in cold and hot water supply lines to each fixture branch, battery of fixtures and at each automatic, solenoid-operated or quick-closing valve serving equipment.

2. Locate and size hydraulic shock absorbers in accordance with PDI-WH-201 Standard and manufacturer’s published recommendations.

3. Install hydraulic shock absorbers with clearances to allow inspection, removal and replacement. Provide access panels where required.

E. Water Pressure Regulating Valves

1. Provide isolation valve, strainer and pressure gauge immediately upstream of each pressure regulating valve.

2. Provide pressure gauge and isolation valve immediately downstream of each pressure regulating valve.

3. Installation shall allow sufficient access to and space around components for adjustments and servicing.

4. Provide services of a direct factory representative for start-up service, inspection and necessary adjustments for all large demand regulators.

END OF SECTION 22 10 30
SECTION 22 40 00 – PLUMBING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This section includes the furnishing of all labor and materials necessary for a complete installation of all plumbing fixtures indicated on the Drawings and specified herein.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:


2. NOTE: MD Anderson takes various exceptions to the International Plumbing Code and has adopted the more stringent requirements within the Uniform Plumbing Code. These exceptions are included within Project Specifications and/or Project Design Drawings.

3. Texas Department of Licensing and Regulation, Texas Accessibility Standards of the Architectural Barriers Act, Article 9102, Texas Civil Statutes


5. ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities" relative to plumbing fixtures for people with disabilities

6. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water

7. Texas Health and Safety Code, Chapter 372, Environmental Performance Standards for Plumbing Fixtures

8. ANSI/ASME A112, Plumbing Standards
1.04 PRODUCTS NOT FURNISHED BUT INSTALLED UNDER THIS SECTION

A. Rough-in for and make final connection to Owner furnished fixtures and equipment requiring plumbing services.

B. Rough-in for and make final connection to fixtures and equipment furnished under other divisions of these Contract Specifications requiring plumbing services.

1.05 QUALITY ASSURANCE

A. Fixtures, trim, accessories and carriers of any one type shall be by the same manufacturer throughout.

B. All fixtures and trim shall be new, institutional/commercial quality and free from mars, chips, scratches, blemishes or any defects.

1.06 SUBMITTALS

A. Product Data:

1. Provide manufacturer’s data sheets indicating Code and Standards compliance, illustrations of fixtures, physical sizes, rough-in dimensions, utility sizes, trim and finishes.

B. Record Documents:

1. Provide full written description of manufacturer’s warranty.

2. Manufacturer’s installation instructions.

C. Operation and Maintenance Data:

1. Include installation instructions, exploded assembly views, servicing requirements, inspection data, installation instructions, spare parts lists, replacement part numbers and availability, location and contact numbers of service depot, for all plumbing specialties installed.

1.07 DELIVERY, STORAGE AND HANDLING

A. Accept fixtures on Site in factory packaging. Inspect for damage.

B. Protect all fixtures and trim before and after installation from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for installation within exterior environments.

C. Protect installed fixtures and trim from damage and/or entry of foreign materials by temporary covers during the construction phase of this project.

D. Do not allow use of installed fixtures and trim for any reason, other than testing, during the construction phase of this project.

1.08 EXTRA MATERIALS

A. Refer to Section 01 78 46 for Maintenance Material Requirements.
1.09 FIELD MEASUREMENTS

A. Verify that field measurements are either as indicated on Shop Drawings or as instructed by the manufacturer. Designate within submittals that measurements have been verified, and note which measurements are the basis for construction.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Stainless Steel Sinks: Just, Elkay
B. Mop Sinks: Crane/Fiat, Stern Williams
C. Drinking Fountains: Oasis, Sunroc, Elkay, Halsey Taylor
D. Bariatric Toilets: Acorn, Whitehall, Willoughby
E. Vitreous China Water Closets: American Standard, Kohler, Crane, Eljer
F. Vitreous China Clinical Flushing Rim Sinks: American Standard, Kohler, Crane, Eljer
G. Vitreous China Urinals: American Standard, Kohler, Crane, Eljer
H. Vitreous China Lavatories: American Standard, Kohler, Crane, Eljer
I. Cast Iron Bathtubs: American Standard, Kohler, Crane, Eljer
J. Manual Lavatory/Sink Faucets: Chicago
K. Manual Laboratory Sink Faucets: Chicago, WaterSaver
L. Electronic Lavatory/Sink Faucets (DC Powered): Chicago “HyTronic”
M. Electronic Lavatory/Sink Faucets (AC Powered): Chicago “HyTronic”
N. Manual Flush Valves: Sloan “Royal” or Zurn “AquaVantage”
O. Manual Flush Valves with Bedpan Washer: Sloan “Royal” or Zurn “AquaVantage”
Q. Electronic Flush Valves (AC Powered): Sloan “Optima” or Zurn “AquaSense”
S. Shower Heads/Hand Sprayer: Chicago, Powers, Leonard, Speakman
T. Bedpan Washers (Hand held): Chicago
U. Fixture Stops & Supplies: Chicago
V. Fixture Traps: Chicago, McGuire
2.02 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide plumbing fixtures as indicated and scheduled on the Contract Drawings and as specified herein.

C. Fixtures, trim and accessories of any one type shall be by the same manufacturer.

D. All vitreous china fixtures shall be white in color unless noted otherwise on Drawings.

E. All plumbing fixture trim within public toilet rooms shall be furnished with vandal-proof trim.

F. All exposed brass fixture trim shall be heavily chrome plated.

G. Fittings and piping shall be brass and, wherever exposed, shall be polished chrome-plated. Provide tight fitting wall or floor escutcheons of chrome-plated brass or stainless steel wherever pipes pass through floors, walls or ceilings.

H. Fixture supplies shall be loose key angle stops with 1/2” I.P.S. female inlets and shall include wall flanges and brass risers. All components shall be chrome plated. In all cases, all piping, tubing, fittings and faucets shall be installed using mechanical non-slip connections, such as bull-nose, flanged, ferrule or threaded fittings. Fittings requiring a friction fit using slip-on or gasket connections are not acceptable. [EXCEPTION: Hose type riser supplies are acceptable when supplied and required by the fixture manufacturer]. Supply riser tubing for lavatories and sinks shall be minimum 3/8” O.D.

I. Provide A.D.A. compliant molded insulation on exposed water and drain piping beneath handicap accessible lavatories and sinks. Insulation shall be designed to allow removal and re-installation for pipe servicing.

J. Unless noted otherwise, install each lavatory, sink and drinking fountain with chrome-plated, 17 gauge trap with cleanout plug that is easily removable for servicing and cleaning. Slip joints shall be permitted only on the fixture trap inlet, within the trap seal and at outlet connection to the trap adapter.

K. Wall mounted water closets, lavatories, urinals and drinking fountains shall be supported with commercial carriers bolted to floor, model to suit installation. Provide concealed arm type carriers for lavatories.

L. Fixtures shall have flow control devices to limit the flow of water to a maximum rate in accordance with the following table:

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Maximum Water Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Shower Valve or Head</td>
<td>2.5 GPM (at 80 psi)</td>
</tr>
<tr>
<td>Non-Patient Shower Valve or Head</td>
<td>2.0 GPM (at 80 psi)</td>
</tr>
</tbody>
</table>
### M. Stainless Steel Sinks

1. Stainless steel sinks shall be 18 gauge, Type 304 stainless steel with insulation undercoating.

2. Provide stainless steel covers for all unused sink faucet/accessory holes. Covers shall be secured with stainless steel bolt and wing nut. Snap-in type covers are not acceptable. Covers shall provide a watertight seal by utilizing rubber gasket or plumbers putty.

3. Sink strainer shall be 316 stainless steel.

### N. Housekeeping Mop Sinks

1. Provide mop sink having dimensions as scheduled on Contract Drawings

2. Receptor shall be precast terrazzo composed of marble chips and Portland cement, ground smooth, grouted and sealed to resist stains.

3. Stainless steel caps shall be cast integral on all curbs.

4. Shoulders shall not be less than 9-3/4" high inside (12" high outside) measurement, and not less than 1-1/4" wide. Drop front shoulders shall have 6" high outside measurement.

5. Tiling flanges shall be cast integral and extend 1" above shoulder on 1, 2 or 3 sides (as required per Project).

6. Drain shall be cast brass with stainless steel strainer cast integral and shall provide for a code compliant connection to a 3" pipe.

### O. Bariatric Toilets

1. Unit shall conform to ADA requirements and withstand loads up to 2,000 pounds with no measurable deflection and loads up to 5,000 pounds with no permanent damage.

2. Fixture shall be floor mounted fabricated from 14 gage, type 304 stainless steel with side access panels. Construction shall be seamless welded construction and white epoxy antimicrobial finish.

3. Toilet shall be ASME A112.19.3 and CSA B45.4 compliant. Toilet shall evacuated bowl contents with a minimum water consumption of 1.28 gallons per flush. Toilet trap shall be fully enclosed and have a minimum 3-1/2" seal that shall pass a 2-1/8" diameter ball.

4. Toilet shall have a floor mounted elongated bowl with a self-draining flushing rim and top spud.

5. Provide unit having wall or floor waste outlet as required.

6. Provide hinged open-front seat (less cover) rated for minimum 1,200 pounds.
7. Provide in-patient room toilets with bedpan lugs.

P. Water Closets
   1. Water closets shall be vitreous china, wall-mounted elongated bowl having siphon jet flushing action design.
   2. Water closet bowls installed within non-ambulatory patient toilet rooms shall be furnished with slotted rim for bedpan holding.
   3. Water closet bowl gaskets shall be neoprene, felt gaskets and wax rings are not permitted.
   4. Wall mounted water closets shall be supported with extra-heavy duty commercial carriers bolted to floor and rated for a 500 pound load. Carrier model shall be designed for the actual fixture being supported and provided with all options and accessories manufactured by the carrier manufacturer for a complete installation. Provide auxiliary foot support as recommended by the manufacturer to prevent bending of fixture support stud bolts.
   5. Water closet seats shall be commercial/institutional grade, white in color, have open front and stainless steel self-sustaining check hinges.

Q. Flush Valves
   1. Water closet and urinal flush valves shall be chrome plated brass exposed type.
   2. Urinal flush valves shall be electronic sensor operated.
   3. All electronic flush valves shall be provided with manual override activators. EXCEPTION: Flush valves located within specimen collecting toilet rooms shall be hard-wired without manual override activator.
   4. AC powered electronic flush valves located within Patient Care areas and critical Research areas shall be connected to the emergency electrical system.
   5. Flush valves in non-ambulatory patient toilet rooms shall be manually operated and have integral bedpan washer.

R. Faucets
   1. Provide faucets with laminar flow outlets. Aerator shall not be acceptable. Faucet flow control devices shall be located at the spout outlet.
   2. Provide vacuum breakers for all faucets that have threaded or serrated hose connection outlets (including laboratory pure water faucets).
   3. Gooseneck spout outlets shall terminate five inches minimum and six & one half inches maximum above top rim of lavatory or sink. Horizontal dimension from spout inlet to spout outlet shall be a minimum five & one half inches.
   4. Provide integral hot and cold water inlet check stops in all mixing type sink faucets that have hose connection outlets.
5. All non-public use electronic faucets shall be designed and manufactured to allow continuous water flow during usage for at least sixty seconds after initial activation.

6. All electronic lavatory faucets located within public toilet rooms shall be designed and manufactured to allow continuous water flow during usage for a maximum duration of ten seconds after initial activation.

7. AC powered electronic faucets located within Patient Care areas and critical Research areas shall be connected to the emergency electrical system.

8. All lavatory faucets within non-patient room toilets shall have low-profile (non-gooseneck) spouts and electronic sensor activation.

9. Lavatory faucets within patient rooms shall have gooseneck spouts and manually activated four-inch wrist blade operation.

10. Staff Lavatory Faucets:
   a. Chicago – HyTronic Traditional with internal temperature control mixer, 2.2 GPM flow outlet, Model 116.211.AB.1 for DC power, and Model 116.111.AB.1 for AC power.

11. Public Toilet Room Lavatory Faucets
   a. Chicago – HyTronic Traditional with internal temperature control mixer, .05 GPM flow outlet, Model 116.211.AB.1 for DC power and Model 116.111.AB.1 for AC power.

S. Shower and Bathtub Mixing Valves
   1. Shower and bathtub mixing valves shall be ASME A112.18.1M, CSA B125, ASSE 1016 and ADA compliant, having combination thermostatic/pressure balancing replaceable cartridge, integral check valves, integral stops and high temperature limit set at 110° F.

   2. Thermostatic/pressure balance mixing valves shall have brass body construction with polished chrome plated finish, lever control handles for volume and temperature, and 1/2" NPT connections.

   3. Provide showerheads, tub spouts, hand-held shower systems, diverters, vacuum breakers and other trim accessories as scheduled on Contract Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories, sinks, faucets and related trim and accessories.

C. Verify that electric power is available and of the correct characteristics.
3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes required by code, as recommended by the manufacturer, and as indicated in Contract Drawings fixture rough-in schedule.

3.03 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with or properly incidental to the installation of complete plumbing fixtures, as indicated on Contract Drawings, reasonably implied therein or as specified herein, unless specifically excluded.

D. Each piece of trim shall be furnished whether specifically mentioned or not, in order to provide a complete first-class installation. Furnish and install all required water, waste, soil and vent connections to all plumbing fixtures, together with all fittings, supports, fastening devices, cocks, valves, traps, etc., leaving all in complete working order.

E. Provide accessible check valves in the individual cold and hot water fixture supply lines serving mixing valve type faucets or assemblies having hose connection outlets that are not equipped with integral check stops.

F. Coordinate mounting heights of plumbing fixtures with architectural details/elevations.

G. Install A.D.A. compliant water closet flush valve handles on wide side of toilet stalls.

H. Install fixtures and trim in accordance with manufacturer’s instructions.

I. All exposed chrome plated, polished or enameled fixtures and trim shall be installed with special care, leaving no tool marks on finishes. Install flexible brass fixture supply risers using manufactured tube bending tools. Bending tubes only with the use of hands shall not be permitted.

J. Install each fixture trap, easily removable for servicing and cleaning.

K. Provide chrome-plated deep escutcheons where required to cover non-chrome-plated piping projecting through walls.

L. Thoroughly fill spaces between fixtures and walls, countertops and/or floors with waterproof, mold resistant, non-toxic, non-shrinkable white tile caulking.

M. Install components firmly fixed, level and plumb.

N. Install and secure all wall mounted fixtures in place with commercial carriers and bolts in accordance with manufacturer’s instructions. Fixture weight shall not be transmitted to walls, partitions or service piping. Installation shall prevent any movement of fixture during use.
O. All non-monolithic shower floors shall be provided with drain pan attached to floor drain flange in accordance with the latest edition of the Uniform Plumbing Code. Refer to Architectural Contract Specifications and Drawings for pan materials and additional installation requirements.

3.04 INTERFACE WITH OTHER PRODUCTS AND TRADES

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

B. Provide templates for all fixtures to be mounted in millwork to General Contractor.

C. Coordinate with Electrical Contractor and insure proper power is provided for electric drinking fountains, sensor operated faucets and sensor operated flush valves

3.05 TESTING

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

B. Adjust and set sensor faucet mixing valves to provide desired water temperature at spout outlet.

C. Insure that all traps are filled with water and maintain trap seal. Each fixture shall be filled and then drained. Traps and fixture connections shall be proven water tight by visual inspection.

D. After fixtures have been installed and water systems are pressurized, test each fixture and associated trim for proper operation and inspect for leaks. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all components operate properly.

E. Test drain pans installed for non-monolithic shower floors prior to installation of finished flooring. Fill pan with water to within 1” of top. Pan must maintain test water level without leakage for at least eight hours

3.06 CLEANING

A. Thoroughly clean all plumbing fixtures and equipment furnished under this Contract prior to final acceptance.

B. Thoroughly flush and clean all faucet spout outlet screens and flow control devices.

3.07 PROTECTION OF FINISHED WORK

A. Do not permit use of fixtures until after Substantial Completion has been announced by Owner.

END OF SECTION 22 40 00
SECTION 23 05 90 – CONTRACTOR COORDINATION WITH TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to prepare the building HVAC systems for testing, adjusting, and balancing (TAB) Work indicated by the Contract Documents, including the following:

1. Preparation of air systems for testing, adjusting and balancing.
2. Preparation of hydronic and steam systems for testing, adjusting and balancing.
3. Providing materials and labor to assist TAB Firm in meeting testing, adjusting and balancing requirements.

B. Testing, adjusting and balancing of the air conditioning systems and related ancillary equipment will be performed by a technically qualified TAB Firm. The preparation for and corrections necessary for the testing, adjusting and balancing of these systems, as described herein, are the responsibility of this Contractor.

C. Make any changes or replacements to the sheaves, belts, dampers and valves required for correct balance as advised by the TAB Firm, at no additional cost to the Owner.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

2. AABC: Testing and Balancing Procedures.

1.04 QUALITY ASSURANCE

A. Provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including during the testing, adjusting and balancing period.

B. In order that systems may be properly tested, adjusted, and balanced, the Contractor shall operate systems at Contractor's expense for the length of time necessary to properly verify the systems' completion and readiness for TAB.

C. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. Allow adequate time for the testing and balancing activities during the construction period and prior to Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL

A. None used.

PART 3 - EXECUTION

3.01 PREPARATION

A. Contractor shall be responsible to prepare the building heating, ventilating, and air conditioning systems ready for TAB when scheduled.

B. Operational readiness requires that construction status of the building will permit the closing of doors, windows, ceilings installed, etc., to obtain simulated or projected operating conditions.

C. Notification of System Readiness:

1. Upon completion of the system installation Work, the Contractor shall notify the Owner and TAB Firm in writing, certifying that the Work has been accomplished and that the air conditioning systems are in operational readiness for testing, adjusting, and balancing.

2. TAB Firm shall notify the Contractor of TAB Firm's readiness for balancing.

3. Should the TAB Firm be notified as described above, and the TAB Work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by a duly appointed representative of the Owner, Architect, TAB Firm and the Contractor. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted Work accomplished by the TAB Firm shall be the responsibility of the Contractor.
3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Allow sufficient time for the TAB Firm to perform TAB Firm’s Work within the Project schedule. Complete installation Work by system or floor, whichever is the most efficient for scheduling. Develop the Project schedule in close coordination with the TAB Firm.

D. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions. Install these devices in a manner that will leave the devices accessible and readily able to be adjusted. Immediately correct any malfunction encountered that the TAB Firm reports so that the balancing Work can proceed with minimal delay.

E. Contractor shall promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB Work.

3.03 SYSTEMS VERIFICATION

A. Air Distribution Systems:

1. Verify installation for conformity to the Contract Documents. All supply, return, and exhaust ducts shall be terminated and pressure tested for leakage as required by the Contract Documents.

2. All volume, smoke and fire/smoke dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return, and relief air shall provide tight closure and full opening, smooth and free operation.

3. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices are installed and airflow at each device shall be verified.

4. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be sealed or blanked-off to eliminate excessive uncontrolled bypass or leakage of air.

5. All fans (supply, return and exhaust) operating and verified for freedom from vibration, with proper fan rotation and belt tension. Heater elements in motor starters are of proper size and rating. Record motor amperage and voltage on each phase at Start-up and running, and verify they do not exceed nameplate ratings.

6. All single and/or double duct variable and constant volume terminal units (“mixing boxes”) shall be installed and functional (i.e. controls functioning).

7. Duct systems and air handling units and coils are clean and free of debris.

8. Air systems are pressure independent and can be tested by floor, riser, system, etc. but once the all systems are installed, the total flows and system tracking will require final testing, adjusting and balancing.
B. Water Circulating Systems:

1. Check and verify pump alignment and rotation.

2. Open all valves to their full open position, close bypass stop valves. Set mixing valves to full-flow through systems components. After the system is flushed and checked for proper operation, remove and clean all strainers. Repeat the operation until circulating water is clean.

3. Record the amperage of each pump motor on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating.

4. Verify that the electrical heater elements are of the proper size and rating.

5. All water circulating systems shall be full and free of air. Expansion tanks shall be set for proper water level and all air vents shall be installed at high points of systems and operating freely. Systems shall be cleaned and flushed. Chemicals shall be added to closed systems to treat piping and inhibit corrosion.

6. Check and set operating temperatures and other parameters of the heat exchangers and control devices to the design requirements.

7. Installation and system verification of condenser water, hot water, and chilled water systems must be 100 percent complete prior to balancing.

C. Building Automation System (BAS):

1. Verify that all control components are installed in accordance with the Contract Documents and that all control components are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.

2. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats or sensors, which shall be calibrated at the completion of TAB services with cooperation between the TAB Firm and BAS Provider.

3. BAS Provider shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB Firm that the building automation system is operational. The BAS Provider shall provide technical support, including technicians and necessary computers, to the TAB Firm for a complete check of these systems.

4. BAS Provider shall assist the Contractor with functional performance testing and point-to-point testing back to the main graphics.

5. BAS Provider, if requested by Owner, shall set-up controls on sample fan powered terminal units at TAB Firm’s office.

END OF SECTION 23 05 90
SECTION 23 05 93 – SYSTEM TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by a technically qualified TAB Firm.

B. TAB Firm shall be capable of performing the TAB services as specified in accordance with the Contract Documents, including the preparation and submittal of a detailed report of the actual TAB Work performed.

C. TAB Firm shall check, adjust, and balance components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the system equipment is operating economically and efficiently. This is intended to be accomplished after the system components are installed and operating as specified in the Contract Documents. It is the responsibility of the Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC Standard, Latest Edition or NEBB Standards for Testing, Adjusting, Balancing of Environmental Systems (Latest Edition).

D. TAB Firm shall check, adjust, and balance all hydronic systems including pumps, water distribution systems, chillers, cooling towers, boilers, heat exchangers, coils, and related equipment.

E. Liaison and Early Field Inspection:

1. TAB Firm shall act as a liaison between the Owner, Architect and Contractor. TAB Firm shall perform the following reviews (observations) and tests:

   a. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to the ability to satisfactorily balance systems.

   b. Test at least one or at least 10 percent of the single and fan-powered terminal units if the number of units are greater then twenty (20), for casing and damper leakage when the shipment arrives at the Project Site. All testing (except for the initial terminal units) shall be performed at the Project Site.
c. Test one (1) lab configuration including fume hood with air valve, general exhaust air with air valve and supply air with air valve for performance capability through a full range of inlet pressures. The tracking capability of the exhaust air versus the supply air will be with the submitted hood sash fully open and as the sash is closed in 2 inch increments until fully closed. Track the valves’ response time in relation to sash movement and the lab differential.

2. During the balancing process, as the TAB Firm discovers abnormalities and malfunctions of equipment or components, the TAB Firm shall advise the Contractor in writing so that the condition can be corrected by the Contractor prior to finishing the TAB scope of Work. Data from malfunctioning equipment shall not be recorded in the final TAB report.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:


5. CTI - Cooling Technology Institute CODE ATC-105.

1.04 QUALITY ASSURANCE

A. TAB Firm shall have operated a minimum of five (5) years under TAB Firm’s current name and shall be in good standing with the State of Texas, Franchise Tax Board. TAB Firm shall submit full incorporated name, Charter Number, and Taxpayer's I.D. Number for proper verification of TAB Firm’s status.

B. TAB Firm’s personnel performing Work at the Project Site shall be either professional engineers or certified air and water balance technicians, who shall have been permanent, full time employees of the TAB Firm for a minimum of six (6) months prior to the start of Work for this Project.

C. TAB firm shall have a background record of at least five (5) years of specialized experience in the field of air and hydronic system balancing and shall possess properly calibrated instrumentation.
1.05 SUBMITTALS

A. The activities described in this Section shall culminate in a report to be provided in quadruplicate (4), individually bound and also provided electronically to the Contractor to be presented to the Owner. Neatly type and arrange data. Include with the data, the dates tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the report is to provide a reference of actual operating conditions for the Owner’s operations personnel.

B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

C. At the Owner’s option, all data sheets tabulated each day by TAB Firm personnel shall be submitted for review and sign-off by the Owner’s Construction Inspector. Those data sheets, as initialed by Owner’s Construction Inspector, shall be presented as a supplement to the final TAB report.

D. Submit reports on electronic forms approved by the Owner and Architect/Engineer which will include the following information as a minimum:

1. Title Page:
   a. Company name.
   b. Company address.
   c. Company telephone number.
   d. Project name.
   e. Project location.
   f. Project Manager.
   g. Project Engineer.
   h. Project Contractor.
   i. Project identification number.

2. Instrument List:
   b. Manufacturer.
   c. Model.
   d. Serial number.
   e. Range.
f. Calibration date.

g. What test instrument was used for.

3. Fan Data (Supply and Exhaust):
   a. Identification and location.
   b. Manufacturer.
   c. Model.
   d. Air flow, specified and actual.
   e. Total static pressure (total external), specified and actual.
   f. Inlet pressure.
   g. Discharge pressure.
   h. Fan RPM.

4. Air Handler Return Air/Outside Air Data (If fans are used, provide fan data as noted above):
   a. Identification and location.
   b. Design return air flow.
   c. Actual return air flow.
   d. Design outside air flow.
   e. Return air temperature.
   f. Outside air temperature.
   g. Required mixed air temperature.
   h. Actual mixed air temperature.

5. Electric Motors:
   a. Manufacturer.
   b. Horsepower/brake horsepower.
   c. Phase, voltage, amperage, nameplate, actual.
   d. RPM.
   e. Service factor.
   f. Starter size, heater elements, rating.
6. V-Belt Drive:
   a. Identification and 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.

7. Duct Traverse:
   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.

8. Air Monitoring Station Data:
   a. Identification and location.
   b. System.
   c. Size.
   d. Area.
   e. Design velocity.
   f. Design air flow.
   g. Test velocity.
   h. Test air flow.

9. Variable or Constant Volume Terminal Unit Test Sheet:
1. Identification number.

2. Room number/location.

3. Terminal type (FP if fan powered) and / or (SDVV, SDCV, DDVV, DDCV), and (HWRH or ERH if reheat coil is used).

4. Terminal size.

5. Area factor.

6. Design velocity.

7. Design maximum and minimum air flow.

8. Test (final) velocity.

9. Test (final) maximum and minimum air flow.

10. For DDC instrumentation: Measure and record computer readout and calibration factor at the final measurement conditions.

11. Air dry bulb temperature at the discharge of the terminal unit.

10. Pump Data:

   a. Identification and location.

   b. Manufacturer.

   c. Size/model.

   d. Impeller size.

   e. Service (CTW, CHW, CDW, HW, etc.).

   f. Developed head pressure and BHP at design flow rate.

   g. Developed head pressure and BHP at actual flow rate.

   h. Pump discharge pressure.

   i. Pump suction pressure.

   j. Total operating head pressure at final balance.

   k. Shut off, discharge and suction pressure.

   l. Shut off, total head pressure.

   m. Pressure differential settings.

   n. Fluid temperature.

11. Cooling Coil Data:
a. Identification number.
b. Location.
c. Service.
d. Manufacturer.
e. Entering air DB temperature, design and actual.
f. Entering air WB temperature, design and actual.
g. Leaving air DB temperature, design and actual.
h. Leaving air WB temperature, design and actual.
i. Water pressure flow, design and actual.
j. Water pressure drop, design and actual.
k. Pressure independent control valve water pressure drop, design and actual.
l. Entering water temperature, design and actual.
m. Leaving water temperature, design and actual.
n. Air quantity CFM design, and CFM actual.
o. Air pressure drop, design and actual.
p. Sensible Btu/hr design, and actual.
q. Total Btu/hr design, and actual.

12. Heating Coil Data:
   a. Identification number.
   b. Location.
   c. Service.
   d. Manufacturer.
   e. Air flow, design and actual.
   f. Water flow (gpm) or Steam mass flow rate (lbs per hour) design and actual.
   g. Pressure drop water (feet w.g.) or steam (psid), design and actual.
   h. Pressure independent control valve water pressure drop, design and actual.
   i. Entering water or steam temperature, design and actual.
   j. Leaving water or steam temperature, design and actual.
k. Entering air temperature, design and actual.

l. Leaving air temperature, design and actual.

m. Air quantity CFM design, and CFM actual.

n. Air pressure drop, design and actual.

o. Sensible Btu/hr design, and actual.

p. Electric heat kW, number of stages, kW per stage – specified and actual (if applicable).

13. Heat Exchanger Data:

a. Identification and location.

b. Service.

c. Manufacturer.

d. Steam flow rate, design and actual.

e. Water flow rate, design and actual.

f. Water pressure drop, design and actual.

g. Pressure independent control valve water pressure drop, design and actual.

h. Entering steam temperature and pressure, design and actual.

i. Entering water temperature, design and actual.

j. Leaving water temperature, design and actual.

k. Electric heat, full load kW, number of stages, kW per stage – specified and actual (if applicable).

14. Chiller:

a. Identification and location.

b. Manufacturer and model number.

c. Condenser cooling medium (water or air cooled).

d. Number of compressor types and number of stages.

e. Chilled water entering and leaving temperature - specified and actual - one hour log.

f. Condenser water entering and leaving temperature - specified and actual - one hour log.

g. Evaporator section and condenser section water side pressure drop - specified and actual.
h. Air cooled condenser entering and leaving dry bulb temperatures.

i. Compressors full load amperage - specified and actual.

j. Voltage, phase, and cycle - specified and actual.

k. Ambient temperature, DB/WB, time of day, and weather conditions at time of test.

l. Cooler tons, condenser tons, and measured operating kW / ton compared to factory certified performance test data.

15. Cooling Tower:

a. Identification and location.

b. Manufacturer.

c. Model number.

d. Size and serial number.

e. Motor horsepower and RPM.

f. Voltage, phase, hertz.

g. Full load amps.

h. Running amps.

i. Cooling tower water flow rate through the tower.

j. Cooling water flow rate through the bypass piping.

k. Air entering and leaving wet bulb temperatures.

l. Record airflow velocities and rates at the tower air inlets.

m. Specified and actual tons capacity at design conditions.

16. Hot Water Boiler or Steam Boiler:

a. Identification and location.

b. Unit manufacturer and model number.

c. Heating water flow gpm - specified and actual (if applicable).

d. Steam capacity lbs per hour - specified and actual (if applicable).

e. Steam temperature and pressure - specified and actual.

f. MBtuh Input / output - specified and actual.

g. MBtuh output - specified and actual.
h. Gas / Fuel oil burner CFH / gpm.

i. Gas / Fuel oil inlet pressure, in water / psig.

j. Blower motor horsepower and FLA.

k. Fire rate - gas, therm. / oil, btu per lbm.

l. High fire set point(s).

m. Low fire set point(s).

n. NOx measurement (based on capacity of boiler per the Texas Commission on Environmental Quality).

17. Sound Level Report:

a. Location (Location established by the Engineer).

b. Baseline background NC curve for eight (8) bands – with equipment off.

c. Operating NC curve for eight (8) bands – with equipment on.

18. Vibration Test on equipment having 10 horsepower motors or greater:

a. Location of points:

   1) Fan bearing, drive end.

   2) Fan bearing, opposite end.

   3) Motor bearing, center (if applicable).

   4) Motor bearing, drive end.

   5) Motor bearing, opposite end.

   6) Casing (bottom or top).

   7) Casing (side).

   8) Duct after flexible connection (discharge outlet).

   9) Duct after flexible connection (suction inlet).

b. Test readings:

   1) Horizontal, velocity and displacement.

   2) Vertical, velocity and displacement.

   3) Axial, velocity and displacement.

c. Normally acceptable readings, velocity and acceleration.
d. Unusual conditions at time of test.

e. Vibration source (if non-complying).

19. Control verification indicating date performed and any abnormalities identified:

a. Point Location/Description.

b. EMS Readout (Setpoint and Actual).

c. Actual Readout.

d. Interlocks.

e. Safeties:

1) VSD Normal Operation.

2) VSD Bypass Operation.

f. Alarms.

g. Sequences of Operation.

20. Include in the appendix all submittals for air handling units, pumps, fans, heat exchangers, energy recovery units control system, etc.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 AIR BALANCE

A. When systems are installed and ready for operation, the TAB Firm shall perform an air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within +/- 5 percent of the value shown on the Drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device opposed blade damper (OBD) for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown.

B. The general scope of balancing by the TAB Firm shall include, but is not limited to, the following:

1. Filters: Check air filters and filter media and balance only systems with essentially clean filters and filter media. The Contractor shall install new filters and filter media prior to the final air balance.
2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Contractor shall make any required changes.

3. Ampere Readings: Measure and record full load amperes for motors.

4. Static Pressure: 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 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.

5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM(s) and temperatures, as applicable, at each fan, blower and coil.

6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and reheat coil at each VAV terminal unit. At the time of reading record water flow and entering and leaving water temperatures (in variable flow systems adjust the water flow to design for all the above readings).

7. Zone Air Flow: Adjust each HVAC VAV terminal unit and VAV air handling unit for design CFM.

8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +/− 5 percent of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and rooms that are negative exhaust air flow shall be set to design +10 percent and supply to design -5 percent. Positive areas will have opposite tolerances.

9. Pitot Tube Traverses: For use in future troubleshooting by Owner, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.

10. Maximum and minimum air flow on terminal units.

3.02 HYDRONIC SYSTEM BALANCE

A. When systems are installed and ready for operation, the TAB Firm shall perform water balance for each chilled and heating hot water system.

B. The general scope of balancing by the TAB Firm shall include, but not be limited to, the following:

1. Adjusted System Tests: Adjust pressure independent control valves at each coil and heat exchanger for design flow, +/- 5 percent, in accordance with valve manufacturer’s published commissioning procedure. Pressure independent valve manufacturer will provide service tool and/or service software for use in this commissioning process, and provide training in its use. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve. (Note: If discharge valves on the pumps are used for balancing record the head being restricted by the valves).
2. Temperature Readings: Read and record entering and leaving water temperature at each water coil, converter and heat exchanger. Adjust as necessary to design conditions. Provide final readings at all thermometer well locations.

3. Test cooling towers in accordance with CTI Code ATC – 105.

4. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating pressure independent control valves, in accordance with valve manufacturer’s published commissioning procedures until the rated pressure drops across each coil is obtained and total water flow is verified by flow measuring status. Verify required pressure drop across each pressure independent control valve. For coils equipped with 3-way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.

5. Ampere Readings: Read and record full load amperes for each pump motor.

3.03 SOUND VIBRATION AND ALIGNMENT

A. Sound: Read and record sound levels at up to fifteen (15) locations per floor in the building as designated by the Architect/Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet and in the presence of the Architect/Engineer, at the Architect/Engineer’s option.

B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 horsepower. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Architect/Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed one mil on fans and one mil on pumps unless otherwise specified. Equipment manufacturer shall rectify all systems exceeding vibration tolerances.

3.04 BUILDING AUTOMATION SYSTEMS

A. In the process of performing the TAB Work, the Contractor shall:

1. Work with the Building Automation System (BAS) Provider and Owner to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.

2. Verify that all control devices are properly connected.

3. Verify that the intended controllers operate all dampers, valves and other controlled devices.

4. Verify that all dampers and valves are in the position indicated by the controller; open, closed, or modulating.
5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes all duct-mounted dampers, dampers in terminal units, and fire/smoke dampers.

6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location. Observe that all pressure independent control valves are properly installed in accordance with manufacturer’s published installation instructions.

7. Observe the calibration and operation of all controllers.

8. Verify the proper application of all normally opened and normally closed valves.

9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.

10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. BAS Provider will relocate sensors as deemed necessary by the TAB Firm or Contractor.

11. Verify that the sequence of operation for any control mode is in accordance with approved Shop Drawings and Specifications. Verify that no demand for simultaneous heating and cooling occurs at the terminal units.

12. Verify that all controller setpoints meet the Contract Documents.

13. Check all dampers for free travel.

14. Verify the operation of all interlock systems.

15. Perform variable volume system verification to assure the system and system components track with changes from full flow to minimum flow.

3.05 STAIRWELL PRESSURIZATION SYSTEMS

A. With all doors closed, measure the door pull to determine that the opening force required is less than or no greater than 30 pound-force.

B. With all doors closed, measure the pressure differential across each door to verify the pressure differentials at each floor. Pressure differential shall not exceed 0.15 inches w.g. and shall be greater than 0.05 inches w.g.

C. Measure the airflow in the stairwell with the maximum number of doors fully open by pitot tube traverse, if traverse locations are available. If traverse locations are not available, TAB Firm shall measure air flow at each outlet.

D. Verify with smoke that the smoke detector in the stair pressurization fan inlet shuts down the fan.

END OF SECTION 23 05 93
SECTION 23 07 13 – DUCTWORK INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install ductwork insulation and jackets indicated by the Contract Documents with supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.


5. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.


16. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

17. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

18. UL 723 - Surface Burning Characteristics of Building Materials.


1.04 QUALITY ASSURANCE

A. All ductwork requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.

B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this Section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application Company Qualifications: Company performing the Work of this Section must have minimum three (3) years experience specializing in the trade.

D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.

E. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable.

1.05 SUBMITTALS

A. Product Data:
1. Provide product description, list of materials, "k" value, "R" value, mean temperature range, and thickness for each service and location.

B. Record Documents:
   1. Submit under provisions of Division 01.

C. Operation and Maintenance Data:
   1. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.
   2. Manufacturer’s Installation Instructions: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.06 DELIVERY, STORAGE AND HANDLING
   A. Deliver, store, protect, and handle products to the Project Site under provisions of Division 01 and Division 20.
   B. Deliver materials to Site in original factory packaging, labeled with manufacturer’s identification including product thermal ratings and thickness.
   C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.
   D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

PART 2 - PRODUCTS

2.01 GENERAL
   A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS
   A. CertainTeed Corporation.
   B. Johns Manville Corporation.
   C. Knauf Corporation.
   D. Owens-Corning.
   E. Armacell North America.
   F. Unifrax 1 LLC. (FyreWrap)
   G. 3M Fire Protection Products (Fire Barrier Duct Wrap 615+)

2.03 INSULATION MATERIALS
   A. Type D1: Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.
B. Type D2: Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.

C. Type D3: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable acrylic surface coating specifically formulated to:

1. Be no more corrosive than sterile cotton when tested in accordance with the test method for corrosiveness in ASTM C665.
2. Absorb no more than 3 percent by weight when tested in accordance with the test method for moisture vapor sorption in ASTM C1104.
3. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM C1071, ASTM C1338, ASTM G21, and ASTM G22.
4. Show no signs of warpage, cracking, delaminating, flaming, smoking, glowing, or any other visibly negative changes when tested in accordance with the test method for temperature resistance in ASTM C411.
5. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
6. Meet the sound absorption requirements when tested in accordance with the test method for sound absorption in ASTM C423.
7. Show no evidence of continued erosion, cracking, flaking, peeling, or delamination when tested in accordance with the test method for erosion resistance in UL181.

D. Type D4: Fire Rated Grease Duct Insulation (High Temperature Flexible Blanket); 1-1/2-inch thick refractory grade fibrous fire barrier material with minimum service temperature design of 2,000 degrees F; aluminum foil laminated on both sides; with a minimum 'k' value of 0.25 and a minimum density of 6 lbs/cu ft; containing no asbestos. Listed by a nationally recognized testing laboratory (NRTL) UL to meet ASTM E 2336, ASTM E119, and with flame spread/smoke minimum rating of 25 / 50 when tested as per ASTM E84/UL 723.

E. Type D5: Outdoor Duct Insulation (Closed Cell Flexible Elastomeric Insulation); 1 inch thick material that has a service temperature range from –60 degrees F to 180 degrees F. This outdoor duct insulation meets ASTM C 177 or C 518 and shall have minimum 'k' value of 0.27 Btu·in. / hr·ft²·degrees F at minimum density measurement of 3 lb/cu ft. The insulation and outside surface must be protected with a white Thermo Plastic Rubber Membrane formulated to:

1. Be resistant to UV, and ozone, acid rain, and physical elements produced from outdoor weather per ASTM E 96 Procedure A.
2. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
3. Show no evidence of continued erosion, delaminating, cracking, flaking, or peeling when tested in accordance with the test method for erosion resistance in UL181. Be resistant to mold growth resistance, ASTM G 21/C 1338 resistant to fungi, and resistant to bacteria growth per ASTM G 22.
F. Type D6: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable polyacrylate copolymer emulsion specifically formulated to:

1. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM D 5590 with “0” growth rating.

2. Act as a fungicidal protective coating: water based, VOC < 50 g/l. Fungicidal coating must be EPA registered for use in HVAC duct systems. Manufacturer: H.B. Fuller Construction Products Inc., Foster 40-20 (white) or 40-30 (black) Fungicidal Protective Coating or approved equal. Coatings may also be used to repair damage to duct liner insulation.

2.04 INSULATION ACCESSORIES

A. Adhesives: Waterproof vapor barrier type, meeting requirements of ASTM C916; Childers CP-82 or Foster 85-20/85-60.

B. Weather Barrier: Breather Mastic; Childers CP-10/CP-11 or Foster 46-50 White.

C. Vapor Barrier Coating: Permeance - ASTM E 96, Procedure B, 0.08 perm or less at 45-mil dry film thickness, tested at 100F and 50%RH; Foster 30-65 or Childers CP-34

1. When higher humidity levels may be of concern, only specify the following fungus/mold resistant coating: Foster 30-80 AF (anti fungal). Coating must meet ASTM D 5590 with 0 growth rating**

D. Reinforcing Mesh: 10x10 or 9x8 glass mesh; Foster Mast a Fab or Childers #10

E. Jacket: Pre-sized glass cloth, minimum 7.8 oz/sq yd.

F. Type D4 Insulation Adhesive: Fire resistive to ASTM E84, Childers CP-82 or Foster 85-20.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Joint Tape: Glass fiber cloth, open mesh.

I. Tie Wire and Wire Mesh: Annealed steel, 16 gage.

J. Stainless Steel Banding: 3/4-inch wide, minimum 22 gage, 304 stainless.

K. Armaflex 520, 520 BLV, or Foster 85-75 contact adhesive.

L. Armatuff 25 white seal seam tape.

PART 3 - EXECUTION

3.01 PREPARATION

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

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

C. Maintain required ambient temperature during and after installation for a minimum period of 24 hours.
### 3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Extend duct insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated.

D. Provide external insulation on all round ductwork connectors to ceiling diffusers and on top of diffusers as indicated in the Ductwork Insulation Application and Thickness Schedule and the Drawings. Secure insulation to the top of ceiling diffusers with UL181B-FX listed polypropylene duct tape. Do not insulate top of ceiling diffuser if it is used in ceiling return air plenum or in an open space with no ceiling.

E. Flexible and Rigid fiberglass insulation (Types D1 and D2) application for exterior of duct:

1. Secure flexible insulation jacket joints with vapor barrier adhesive, tape. Tape shall be UL181B-FX listed polypropylene duct tape.

2. Install without sag on underside of ductwork. Use 4-inch wide strips of adhesive on 8-inch centers and mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

3. Insulate standing seams and stiffeners that protrude through the insulation with 1-1/2 inch thick, unfaced, flexible blanket insulation. Cover with reinforcing mesh and coat with vapor barrier finish coating.

4. On circumferential joints, the 2-inch flange on the facing shall be secured with 9/16 inch outward clinch steel staples on 2-inch centers, and taped with minimum 3-inch wide strip of glass fabric and finish coating.

5. Vapor seal all seams, joints, pin penetrations and other breaks with vapor barrier coating reinforced with reinforcing mesh.

F. Duct Liner (Type D3 or D6) application for interior of return air sound boots:

1. Secure insulation with 100 percent coverage of duct liner adhesive, pins and clips not more than 18 inches on center.

2. Secure bottom of duct insulation using alternate single and double clips. The first pin will secure the insulation and the second clip will be used to secure the cladding. Isolate the exterior clip from the cladding by using two 1/8 inch closed cell neoprene (Armaflex) washers on either side of the cladding. Predrill holes in cladding and avoid contact with pin during installation.

3. For round duct, secure insulation with 100 percent coverage of duct liner adhesive. Secure cladding with 3/4 inch, 0.020 inch stainless steel bands on 12-inch centers.

4. For joints and overlaps, fold cladding to form a double thickness hem 2 inches minimum. Seal with a non-shrink, non-hardening sealing compound.
5. Type D6: Provide fungicidal coating in air handlers ten feet on either side, first ten feet downstream of cooling coils, ten feet downstream of mix boxes, in mechanical rooms or as otherwise specified in potentially high humidity areas in the duct system shall be coated with an fungicidal coating; EPA registered for use in HVAC duct systems at a coverage rate of 80 ft²/gallon.

G. Insulation (Type D4) application for exterior of grease ducts:

1. External duct wrap system requires two (2) 1.5-inch layers of lightweight, flexible wrap overlapped to provide an effective fire barrier. The barrier is installed in 24-inch or 48-inch wide sections. Insulation pins are welded in certain locations to maintain the fire barrier material up against the duct.

2. Grease duct doors to be installed so the door can be removed and reinstalled and meet code requirements.

3. Install duct wrap as tested per manufacturer’s instructions to assure the duct wrap is mechanically attached per the manufacturer’s spacing of bands or weld pins.

4. Vertical and horizontal members of the support hanger system shall be wrapped with one layer of the insulation. Vertical and horizontal portions shall be wrapped independent of one another. The horizontal hanger shall be removed from the vertical support rods and wrapped and then immediately replaced so that an adjacent horizontal support can be removed, wrapped, and reinstalled. The end of the threaded vertical rod shall extend 6-inch past the horizontal member at the beginning of the installation.

5. Penetrations: Where ducts penetrate fire rated walls, floors and roofs, the duct wrap shall be used in conjunction with a firestop system that is listed by a nationally recognized laboratory and rated for penetration of a rated wall or floor by the fire rated grease duct system used.

H. Insulation (Type D5) application for outdoor ducts:

1. Horizontal ductwork located outdoors shall be sloped at a minimum 2-degree angle to prevent the accumulation of water on top of the finished insulated duct. Support members that connect directly to the ductwork are to be insulated with this same material. Keep compression or sharp creases of outdoor insulation to a minimum by distributing the weight of the duct resting on horizontal duct support members.

2. Follow the insulation manufacturer’s installation instructions and procedures to assure the ductwork is properly insulated and that the insulation will meet the manufacturer’s warranty requirements.

I. All ductwork, accessories, and all plenums including metal and masonry construction, etc., shall be insulated as indicated on the Drawings, as specified herein and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

J. Flexible ductwork connections to equipment shall not be insulated.

K. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
L. Extreme care shall be taken in insulating high and medium pressure ductwork including all ductwork between the fan discharge and all mixing boxes to ensure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these Specifications are classified as high velocity ductwork.

M. Where canvas finish is specified use lagging adhesive/coating to prevent mildew in securing canvas. Do not use wheat paste. Use only anti fungal lagging adhesive that adheres to ASTM D 5590 with 0 growth rating. (Foster 30-36AF, Childers CP-137AF). In addition, cover all exterior canvas-covered insulation with a fire retardant weather barrier mastic.

N. All supply ductwork in the Project shall be insulated; all exhaust and fume hood exhaust ductwork shall not be insulated, unless used for energy recovery purposes or noted on drawings.

O. Flexible round ducts shall be factory insulated.

3.03 INSPECTION

A. Visually inspect the completed insulation installation per manufacturers recommended materials, procedures and repair or replace any improperly sealed joints.

B. Where there is evidence of vapor barrier failure or “wet” insulation after installation, the damaged insulation shall be removed, duct surface shall be cleaned and dried and new insulation shall be installed.

3.04 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

<table>
<thead>
<tr>
<th>Ductwork System</th>
<th>Application</th>
<th>Insulation Type</th>
<th>Insulation Thickness</th>
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<tr>
<td>Supply Air</td>
<td>Outside of Mechanical Rooms</td>
<td>D1</td>
<td>2”</td>
</tr>
<tr>
<td>(Hot, Cold, Combination)</td>
<td>Inside of Mechanical Rooms</td>
<td>D2</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>Return Air, Relief Air, and Exhaust Air</td>
<td>All</td>
<td>D1</td>
<td>1”</td>
</tr>
<tr>
<td>Outdoor Air</td>
<td>Treated and Untreated</td>
<td>D1</td>
<td>2”</td>
</tr>
<tr>
<td>Duct mounted coils</td>
<td>Inside of Mechanical Rooms</td>
<td>D2</td>
<td>2”</td>
</tr>
<tr>
<td>Terminal Unit Heating Coils</td>
<td>All</td>
<td>D1</td>
<td>2”</td>
</tr>
<tr>
<td>Supply Air Diffusers</td>
<td>Top of Diffuser</td>
<td>D1</td>
<td>2”</td>
</tr>
<tr>
<td>Supply Air Duct</td>
<td>Outdoor Environment</td>
<td>D5</td>
<td>2”</td>
</tr>
<tr>
<td>Return, Exhaust Air Duct</td>
<td>Outdoor Environment</td>
<td>D5</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>Return Air Sound Boots/Elbows</td>
<td>All</td>
<td>D3</td>
<td>1”</td>
</tr>
</tbody>
</table>

END OF SECTION 23 07 13
SECTION 23 21 13 – HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Furnish and install all labor, materials, equipment, tools and services and perform all the operations required in connection with, or associated with, the construction of complete hydronic piping systems, including chilled and heating hot water piping, condenser water piping process chilled or hot water piping, condensate drain piping and generator cooling water piping systems as indicated on the Drawings.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.


3. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.


5. ANSI/ASME B16.23 – Cast Copper Alloy Solder Drainage Fitting – DWV.

6. ANSI/ASME B16.29 – Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.

7. ANSI/ASME B31.9 - Building Services Piping.

8. ASME B36.1 – Standardization of dimensions of welded and seamless wrought steel pipe for high or low temperatures and pressures.

10. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.


12. ASTM A106 Grade B, Seamless or Electric Resistance Welded (ERW) piping.

13. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.


1.04 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating shall be clearly marked on the outside of the valve body.

B. All grooved joint couplings, fittings, flanges, valves, and specialties of the same type shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

C. Welding Materials and Procedures: Conform to Chapter V, ASME/ANSI B31.9 and applicable state labor regulations.


E. Each threaded fitting shall be stamped as specified by ANSI B16.3.

F. Each welded fitting shall be stamped as specified by ANSI B31.9.

1.05 SUBMITTALS

A. Product Data:

1. Submit product data on pipe materials, pipe fittings, valves, and accessories. Clearly indicate make, model, type, size, and pressure rating for each device.

2. Submittal data for all fittings shall include a letter signed by an official of the manufacturing company certifying compliance with these Specifications.

B. Record Documents:

1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic or Anvil style or series designation.

2. Include welder’s certification of compliance in accordance with Chapter V, ASME/ANSI B31.9.
PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Wall, Floor and Ceiling Plates:
   1. Provide chrome-plated brass floor and ceiling plates.

C. Threaded Fittings:
   1. All threaded fittings shall be USA factory made, wrought carbon or alloy steel threaded fittings conforming to ASTM A234 or malleable iron threaded fittings conforming to ASME B16.3.
   2. Acceptable manufacturers: Grinnell, Tube Turn, Weld Bend Hackney, Taylor Forge or Ladish Company.

D. Grooved Fittings:
   1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. Fittings shall comply with ASTM A536; ASTM A234; or factory fabricated from carbon steel pipe conforming to ASTM A53.
   3. Gaskets shall be verified as suitable for the intended system service, a minimum temperature of 250 degrees, fluid chemistry, and system pressure prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.

E. Welded Fittings:
   1. All welded fittings shall be USA factory made wrought carbon steel butt welding fittings conforming to ASTM Spec. A234 or ASME B16.9.
   2. Acceptable manufacturers: Grinnell, Tube Turn, Weld Burn Hackney, Taylor forge or Ladish Company.

F. Flanges:
   1. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-191 Grade I or II or A-105 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Complete test reports may be required for any fitting selected at random.
   2. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications.
3. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All-thread rods will not be an acceptable substitute for flange bolts. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi.

4. All flanges shall be gasketed. Place gasket between flanges of flanged joints. Gaskets shall fit within the bolt circle on raised face flanges and shall be full face on flat face flanges. Gaskets shall be cut from 1/16 inch thick, non-metallic, non-asbestos gasket material suitable for operating temperatures from -150 degrees F to +750 degrees F, Klingerseal C-4400, Manville Style 60 service sheet packing or accepted substitution. Gaskets must be compatible with flowing fluid, temperature, and pressure of system.

G. Branch Connections:

1. For pipe 2 inches and smaller, use threaded fittings for steel pipe.

2. For 2-1/2 inches through 14 inches welded piping: When branch size is the same as or one size smaller than header size, use a welded tee. Use a Weld-o-let when branch is two or more sizes smaller than the header. For threaded branch connections, use a Thread-o-let welded to header.

3. No Branch connection shall be made by burning a hole in the main.

H. Copper Fittings:

1. Mechanically formed, drilled and extruded tee-branch connections shall not be permitted.

2.02 PIPE

A. TECO Distribution Pipe:

1. Pipe 2-1/2 inches and smaller: Black steel ASTM A106, Grade B, Schedule 80, seamless,
   a. Fittings: Screwed.

2. Pipe 3 inches and larger: Black steel ASTM A106, Grade B, Standard weight seamless,
   c. Flange: ANSI B16.5 Class 150, forged carbon steel.

B. Building Chilled Water and Heating Water Piping – 150 psi System:

1. Steel:
   a. Pipe 2 inches and smaller: Black steel ASTM A106, Grade A or B, seamless, Schedule 40.
1) Fittings: Screwed, malleable iron, Class 150.
2) Joints: Screwed.
3) Unions: Forged steel, ASTM A105, screwed with stainless steel seats.

b. Pipe 2-1/2 inches and larger: Black steel ASTM A106, Grade B, seamless:
   1) 2-1/2 inches through 12 inches – Schedule 40.
   2) 14 inches through 36 inches – 0.375 inch wall thickness.
3) Fittings:
   a) ASTM A234 carbon steel welding type, long radius type elbows unless specified otherwise on the Drawings.
   b) ASTM A536 ductile iron; A234 carbon steel; or factory fabricated A53; grooved end long radius type elbows unless specified otherwise on the Drawings.
4) Joints:
   a) Butt welded.
   b) Grooved mechanical couplings.
5) Flange: ANSI B16.5 Class 150, forged carbon steel.

2. Steel ERW Pipe (Not to be used on HW systems):
   a. 2 inches and smaller Black Steel ASTM A106 Gr. A or B – Schedule 40.
      1) 2” and under ASTM A47, malleable iron, 150 lb.
      2) Joints screwed
      3) Unions: Forged steel, ASTM A105, screwed with stainless steel seats.
   b. 2½ inches to 24 inches Black Steel ASTM A53 Grade B,
      1) 2½ inches through 12 inches – Schedule 40.
      2) 14 inches through 24 inches – 0.375 inch wall thickness.
   c. Fittings: ASTM A234 Carbon steel welding type.
   d. Joints: Butt welded.
   e. Flange: ANSI B16.5 Class 150, forged carbon steel.

3. Copper:
a. Pipe 2 inches and smaller; Copper Tubing: ASTM B 88, Type L, hard drawn. All brass and bronze piping components shall have no more than 15 percent zinc content.

1) Fittings: ASME B16.18, cast bronze, or ASME B16.22 wrought copper and bronze.

2) Joints: ASTM B 32, solder, Grade 95TA (lead free).

b. Pipe over 2 inches: Copper Tubing: ASTM B88, Type K, hard drawn. All brass and bronze piping components shall have no more than 15 percent zinc content.

1) Fittings: ASME B16.18, cast bronze or ASME B16.22, wrought copper and bronze.

C. Building Chilled Water and Heating Water Piping – 300 psi System:

1. Steel:

a. Pipe 2 inches and smaller: Black Steel ASTM A53, Grade A or B, Schedule 40, seamless

1) Fittings: Screwed, AAR malleable iron Class 300.

2) Joints: Screwed.

3) Unions: Forged steel, ASTM A105, screwed with stainless steel seats.

b. Pipe 2-1/2 inches and larger: Black steel ASTM A53, Grade B, seamless:

1) 2-1/2 inches or 12 inches – Schedule 40.

2) 14 inches through 24 inches – 0.375 wall thickness.

3) Fittings:

   a) ASTM A234 carbon steel welding type, long radius type elbows unless specified otherwise on the Drawings.

   b) ASTM A536 ductile iron; A234 carbon steel; or factory fabricated A53; grooved end long radius type elbows unless specified otherwise on the Drawings.

4) Joints:

   a) Butt welded.

   b) Grooved mechanical couplings.

5) Flange: ANSI B16.5 Class 150, forged carbon steel.

2. Copper:

a. Pipe 2 inches and smaller; Copper Tubing: ASTM B 88, Type K, hard drawn.
1) Fittings: ASME B16.8, cast bronze, or ASME B16.22 wrought copper and bronze.

2) Joints:
   a) AWS A5.8 BcuP silver braze (lead free).
   b) Grooved mechanical couplings.

b) Pipe over 2 inches: Copper Tubing: ASTM B 88, Type K, hard drawn.
   1) Fittings: ASME B16.18, cast bronze or ASME B16.22, wrought copper and bronze.
   2) Joints: AWS A5.8 BcuP silver braze (lead free).

3. Stainless Steel:
   a. Pipe 2 inches and smaller; Stainless Steel Piping: ASTM A 312, Type 304/304L, Schedule 5S.
   b. Fittings: Precision, cold drawn, austenitic stainless steel, with elastomer O-ring seals.

D. Generator Cooling Water Pressure:

1. Pipe 2 inches and smaller: Black Steel ASTM A53, Grade A or B, seamless, Schedule 40.
   a. Fittings: Screwed, malleable iron Class 150.

2. Pipe 2-1/2 inches and larger: Black steel ASTM A53, Grade B, seamless:
   a. 2-1/2 inches through 12 inches – Schedule 40.
   b. 14 inches and larger – 0.375 inches wall thickness.
   c. Fittings:
      1) ASTM A234 carbon steel welding type, long radius type elbows unless specified otherwise on the Drawings.
      2) ASTM A536 ductile iron; A234 carbon steel; or factory fabricated A53; grooved end long radius type elbows unless specified otherwise on the Drawings.

3. Joints:
   a. Butt welded.
   b. Grooved mechanical couplings.
   c. Flange: ANSI B16.5 Class 150, forged carbon steel.
4. Stainless Steel:
   a. Pipe 2 inches and smaller; Stainless Steel Piping: ASTM A 312, Type 304/304L, Schedule 5S.

   1) Fittings: Precision, cold drawn, austenitic stainless steel, with elastomer O-ring seals.

E. Chiller Condenser Water Piping:

   1. Pipe: Black steel, ASTM A53, Grade B:
      a. 2-1/2 inches through 12 inches – Schedule 40.
      b. 14 inches and larger – 0.375 inch thickness.

   2. Fittings:
      a. ASTM A234 carbon steel welding type.
      b. ASTM A536 ductile iron; A234 carbon steel; or factory fabricated A53; grooved end type.

   3. Joints:
      a. Butt welded.
      b. Grooved mechanical couplings.


   5. Coat exterior condenser water pipe, valves, and fittings, with minimum 8 mil thick coal tar epoxy.

F. Equipment Drains and Overflows:

      a. Fittings: Galvanized cast iron, ductile iron, steel, or ATM B16.3 malleable iron.
      b. Joints: Screwed, or grooved mechanical couplings.

   2. Tubing: Copper ASTM B88, Type L, hard drawn.
      b. Joints: ASTM B32, solder, Grade 95TA or grooved mechanical couplings.

G. Cooling Coil Condensate Recovery:

      a. Fittings: Galvanized cast iron, ductile iron, steel, or ATM B16.3 malleable iron.
      b. Joints: Screwed, or grooved mechanical couplings.
2. Tubing: Copper ASTM B88, Type L, hard drawn.
   b. Joints: ASTM B32, solder, Grade 95TA or grooved mechanical couplings.

2.03 GROOVED MECHANICAL COUPLINGS AND FITTINGS

A. Grooved mechanical couplings shall consist of two ductile iron housing segments conforming to ASTM A536, with pressure responsive elastomer gasket, and zinc electroplated carbon steel bolts and nuts.

1. Sizes 2-1/2 inches through 8 inches:
   a. Rigid Type Couplings: Installed to provide rigidity and system support and hanging in accordance with ANSI B31.1 and 31.9. Victaulic Style 107 Quick-Vic™ or Anvil Fig. 7400, 7401, 7402.
   b. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 77 or 177 Quick-Vic™ or Anvil Fig. 7012, 7084.
   c. Flange Adapters: Flat face, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741 or Anvil Fig. 7012, 7084.

2. Sizes 10 inches through 12 inches:
   a. Rigid Type Couplings: Installed to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 07 or Anvil Fig. 7401.
   b. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 77or Anvil Fig. 7001.
   c. Flange Adapters: Flat face, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741or Anvil Fig. 7012, 7084.

3. Sizes 14 inches through 24 inches:
   a. Rigid Type Couplings: Installed to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07 or Anvil Fig. 7401, 7401-2.
   b. Flexible Type Couplings: Installed to allow for linear and angular movement. Victaulic Style W77 or Anvil Fig. 7001, 7001-2.
   c. Grooved couplings shall be installed to the required torque.

B. Grooved mechanical fittings shall be manufactured of ductile iron conforming to ASTM A536; forged carbon steel conforming to ASTM A234; or fabricated from carbon steel pipe conforming to ASTM A53.

2.04 VALVES

A. General
1. All valves used in 150 psi circulating systems shall be ANSI Class 150. All valves in 300 psi systems shall be Class 300 valves and shall be constructed of all ASTM B-61 or B-584 composition. All gate, globe and angle valves shall be screw-over-bonnet design. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651 or other corrosion resistant equivalents. Secure written approvals by Owner for the use of alternative materials.

2. The following manufacturers are acceptable: Milwaukee, NIBCO, Keystone, KITZ, Crane, Dezurik, Daniels, Williams, Velan Vogt, Victaulic and Anvil.

3. All iron body valves shall have the pressure containing parts constructed of ASTM designated of A536 grade 65-45-12 ductile iron or A126 class B iron. Stem material shall meet ASTM A582 or A564 stainless steel, B16 Alloy 360, or ASTM 371 Alloy 876 silicon bronze or its approved equivalent model by listed manufacturers.

4. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation A-216-GR-WCB carbon steel. Stems shall meet ASTM designation A-186-F6 chromium stainless steel. Seat ring shall be hard faced carbon steel or 13% chromium A-182-F6 stainless. Handwheels shall be A47 grade 35018 malleable iron or ductile iron ASTM A536.

5. All forged steel body valves shall have the pressure containing parts constructed of ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM-A-182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.

6. All gate valves, globe valves, angle valves and shutoff valves shall have malleable iron hand wheels, except iron body valves 2-½ inches and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

7. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service.

8. Provide stem extensions on all insulated valves.

9. Valve chain operators shall be of cast iron or malleable iron and designed to provide positive grip on wheel. Provide chain guide to prevent chain from slipping or jumping on wheel. Employ rustproof chain complete with closing link of sufficient length to operate at 6 feet-6 inches above floor level.

10. Provide valves suitable for connection to adjoining pipe as specified for pipe joints above. Use valves that are full size of pipe in which installed.

B. Gate Valves:

1. 150 Pound Class Valves:

   a. Threaded pipe 2 inches and smaller: KITZ 42T, Milwaukee 1151, NIBCO T-134, or approved equivalent model by listed manufacturers, bronze body, union bonnet, rising stem, solid wedge disc, threaded.
b. Welded pipe 2-1/2 inches and larger: KITZ 72, Milwaukee F-2885A, NIBCO F-617-0, or approved equivalent model by listed manufacturers, iron body, flanged, OS&Y (Outside Screw and Yoke), rising stem, solid wedge.

2. 300 Pound Class Valves:
   a. Threaded pipe 2 inches and smaller: KITZ 37, Milwaukee F-2894A, NIBCO T-174-A or accepted substitute, bronze body, union bonnet, rising stem, solid wedge with integral seats threaded.
   b. Welded pipe 2-1/2 inches and larger: NIBCO F-667-0 or accepted substitute, iron body, OS&Y, rising stem, solid wedge, flanged.

3. Bolted bonnet with OS&Y (outside screw and yoke) and rising stem design, integral seats, with pressure temperature rating conforming to ANSI B16-34; KITZ 37, Milwaukee 1182, NIBCO T-174-A for 2 inches and smaller.

C. Globe Valves:

1. 150 Pound Class Valves:

2. 300 Pound Class Valves:
   a. Threaded pipe 2 inches and smaller: KITZ 17S Milwaukee 593A, NIBCO T276-AP, Class 300 screwed, inside screw rising stem, bronze body, union bonnet, stainless steel disc.

D. Soft Seated Butterfly Valves:

1. 200 Pound Soft Seated:
   a. KITZ 6123, Milwaukee ML233-E, NIBCO LD-2000 (flanged), Victaulic Vic®-300 MasterSeal™/Vic®-300 (grooved), Anvil7700 Series, 8200 Series or approved equal.
   b. Ductile Iron body with Aluminum Bronze Disc, 400 series stainless steel stem offset from the disk centerline to provide full 360 degree circumferential seating.
   c. Temperature range from -50°F to +200°F.
   d. Valves 6 inches and smaller shall have lockable hand lever operators; 8 inches and larger shall have gear operators.
e. All butterfly valves shall be suitable for bi-directional dead-end service without the need for a downstream flange.

E. High Performance Butterfly Valves:

1. 150 Pound Soft Seated Class Valves:
   a. Milwaukee 6 inch and smaller HP1LCS4212, 8 inch and larger HP1LCS4213, NIBCO LCS-6822, carbon steel lug body valves. ANSI rated Class 150.
   b. Valves to provide tight shutoff up to 285 psi.
   c. Valves 6 inches and smaller shall have lockable hand lever operators; 8 inches and larger shall have gear operators.
   d. Provide 316 or UNS-S31803 stainless shaft, cast stainless steel disc, and soft seat.
   e. Temperature range from -50°F to +200°F.

2. 300 Pound Class Valves: Milwaukee HP3LCS4213, NIBCO LCS-7822 300 lb. ANSI class raised face, lug body, carbon steel body, stainless steel pin and shaft and disc, soft seat, and gear operators.

F. Check Valves:

1. 150 Pound Class Valves:
   a. Threaded pipe 2 inches and smaller: KITZ 29, Milwaukee 508, NIBCO T453-B, bronze body, Class 200, screwed connection, regrinding disc and seat with screw in cap.
   b. Welded or Grooved pipe 2-1/2 inches and larger: Milwaukee 1800 series, NIBCO F910-B. Flanged style, or Victaulic Series 716 or 779 or Anvil7800 Series grooved style spring-loaded type. Rate for 150 psig working pressure; Cast or ductile Iron body, Bronze plates and 316 Stainless Steel springs.

G. Plug Valves:

1. 150 Pound Class Valves:
   a. Threaded pipe 2 inches and smaller: Dezurik 128 S 1 RS 26, Keystone 542, 150-pound screwed, eccentric plug valve, carbon steel or semi steel body, Buna-N faced plug, lever operated, nonlubricated, short pattern plug valve.
   b. Welded pipe 2-1/2 inches and larger: Dezurik 128 F 1 RS 26, Homestead 583, or Victaulic Series 377 or Anvil equivalent. 150-pound flanged or grooved eccentric carbon steel or semi steel, Hycar or Buna-N faced plug, manually operated, nonlubricated, short pattern plug.

2. 300 Pound Class Valves:
a. Threaded pipe 2 inches and smaller: Tufline 066, Powerll 3058. 300 psi working pressure, cast carbon steel body and plug, threaded end valve, bolted bonnet, nonlubricated or lubricated with lubricant suitable for water -20 degrees F to 450 degrees F temperature, wrench operated.

b. Flanged piping 2-½ inches, cast carbon steel body and plug conforming to ASTM A216, Gr. WCB. Gear operated, bolted gland. Flanged per ANSI B16.5. Pipe sizes 4 inches through 12 inches. Nonlubricated or lubricated with lubricant suitable for water -20 degrees F to 450 degrees F temperature, 100 percent port.

H. Ball Valves:

1. Threaded pipe 2 inches and smaller: KITZ 68M with ISE Stem Extension and built in memory stop device, Milwaukee BA400-SXM for 3" Milwaukee BA100-SXM, NIBCO T 585-70-66-LL. For threaded pipe 2-1/2 inches to 3 inches: Crane 9303-S or approved equivalent model by listed manufacturers.

a. Threaded full port two-piece bronze body (ASTM-B584 Alloy 844, ASTM B61, or ASTM B62 (ASTM Approved Alloys” only).

b. Stainless steel ball and stem, blowout proof stem with stem extension made of non-thermal conducting material and having an adjustable memory stop after insulation is installed.

c. Ball valves shall be provided with SS lockable handles and locking devices or KITZ 68M Stem Extension and built in memory stop device.

2. Welded or grooved pipe 2-1/2 inches and larger: Milwaukee F20-CS-150-F-02, NIBCO F-515-CS-66FS or accepted substitute for 150 pound Class; Milwaukee F20-CS-300-F-02, NIBCO F-535-CS-66FS for 300 pound class, split steel body, full bore, blowout proof stem with, flanged connections, or Victaulic Series 726 with grooved connections or Anvil Series 7500.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

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

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

D. After completion, fill, clean, and treat systems.

3.02 PIPING STORAGE REQUIREMENT

A. All ERW and seamless piping shall be clearly identified and stored on separate construction pipe racks to prevent the intermixing of piping.

B. Shop fabricated piping spool and pup pieces of ERW and seamless pipe shall be clearly identified and separated in the lay down yard to prevent the intermixing of piping.
3.03 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All valve installations shall be in accordance with manufacturer’s published recommendations.

C. Pipe Installation:

1. All the various piping systems shall be made up straight and true and run in orderly manner, plumb and parallel to building structural. Install piping to conserve building space. Coordinate location with other trades and do not interfere with use of space for other work.

2. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the Site.

3. Should any unforeseen conditions arise, lines shall be changed or rerouted after proper approval has been obtained.

4. 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, or in equipment to which the lines are connected.

5. Group piping whenever practical at common elevations.

6. Slope piping and arrange system to drain at low points. Use eccentric reducers where applicable to maintain the bottom of pipe level.

7. Branch tap connections are to be from the top to horizontal position of pipe run.

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

9. Provide and install Pete’s plugs adjacent to thermo wells for electronic temperature sensors, to electronic pressure sensors and install Pete’s plugs adjacent where shown or noted on piping drawings or drawing details. The piping taps for the Pete’s plugs, permanently mounted pressure gauges, and instruments sensors shall be a minimum size of ½ inch schedule 40 pipe and be able to isolate them with a ½ inch stainless steel ball valve. Systems provided with pressure independent control valves shall be provided with a Pete’s plug downstream of the control valve, to facilitate verification of the valve manufacturer’s recommended water pressure drop across the pressure independent control valve.

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

11. Prepare pipe, fittings, supports, and accessories for finish painting. Chilled water piping insulated with cellular glass does not require finish painting.

12. All piping shall be clean when it is installed. Before installation it shall be checked to assure it is the correct material to be used on the piping system, upended, swabbed if necessary, and all rust or dirt from storage or from lying on the ground shall be removed.
13. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

14. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon tape or Teflon-based compound appropriate to the medium, material and temperature range of the system. Compound shall be 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 upended and hammered to remove all shavings and foreign material.

D. Valve Installation:

1. Locate all valves such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so the valve stem is inclined one bolt hole above the horizontal position.

2. Screw pattern valves placed in horizontal lines shall be installed with their valve stems include at an angle of a minimum of 30 degrees above the horizontal position.

3. Pressure independent control valves shall be installed in accordance with valve manufacturer’s published installation instructions, with regard to orientation, clearances, and lengths of straight pipe upstream and downstream of the valve.

4. All valves must be true and straight at the time the system is tested and inspected for final acceptance.

5. Valves shall be installed as nearly as possible to the locations indicated in the Drawings. Any change in valve location must be so indicated on the Record Drawings.

6. Provide line shut-off valves at locations required for proper operation, servicing and troubleshooting of the HVAC hydronic distribution systems and connected components. Locations shall include but not be limited to the following; at each piece of equipment, at each branch take-off from mains, at the base of each riser, where recommended by equipment manufacturers and at strategic locations to allow sectional isolation while limiting disruption of services to large portions of the system.

7. All valves must be of threaded or flanged type. No solder connected valves shall be used on this Project.

8. Equipment, valves, expansion joints, relief devices, strainers, etc., must be removed or isolated during the test if the pressure/force ratings of the devices are not as high as that specified for the test. Piping shall be drained and protected any time ambient temperature is below freezing.

9. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

10. All threaded valves, installed in copper piping shall be provided with copper or bronze male adapters on each side of valves. Sweat solder adapters to pipe before installing valves.
11. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with architectural drawings.

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

13. All manually operated shutoff valves to equipment that are 2-1/2 inches and larger located 8 feet (Bottom of pipe) or higher above finished floor or stationary platform in mechanical rooms and accessible pipe chases or as noted on Project Drawings shall be chain wheel operated. Chains shall be installed and secured to allow clear passage at walk through areas.

3.04 TESTING

A. All welds are subject to inspection, visual and/or x-ray, for compliance with Specifications. The Owner will, at the Owner’s 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 re-inspection 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 B31.9 due to the discovery of poor, unacceptable or rejected welds.

B. 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.

C. System Pressure Tests:

<table>
<thead>
<tr>
<th>Line</th>
<th>Testing Medium</th>
<th>Testing Pressure (psig)</th>
<th>Time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water and Condenser Water</td>
<td>Water</td>
<td>1-1/2 times working pressure, minimum 125</td>
<td>24</td>
</tr>
<tr>
<td>Heating Water and Generator Cooling Water</td>
<td>Water</td>
<td>1-1/2 times working pressure, minimum 125</td>
<td>24</td>
</tr>
</tbody>
</table>

1. Refer to the Drawings for system design pressure.

3.05 HOT TAP PROCEDURE

A. Contractor shall provide MD ANDERSON drawings with the location of all hot taps shown 10 days prior to scheduled start of work. Contractor shall also clearly identify all locations in the field.

B. Upon receipt of drawings MD ANDERSON will field verify abatement requirements. MD ANDERSON will also identify and coordinate, through the building mission groups, the impact of potential system shut downs, Owner requirements and will issue a notice to proceed.

C. Upon MD ANDERSON’s issuance of a notice to proceed the Contractor shall perform the following hot tap procedures:
1. Preparation
   a. Remove insulation at identified and approved hot tap locations and save for reinstallation as noted below.
   b. Ultra-sound pipe at each weld location to verify pipe thickness. If pipe fails to pass ultra-sound follow procedure outlined in paragraph A to establish new tap location.
   c. Temporarily reinstall pipe insulation upon completion of ultra-sound to prevent condensation.
   d. Repeat above listed steps on all approved hot tap locations.

2. Installation
   a. Remove insulation as required for installation of scheduled hot tap.
   b. Weld saddle sleeve to pipe. All welds shall be made as per 15510-1.06-B
   c. Install new valve on saddle sleeve.
   d. Install blind flange on valve to prevent accidental opening.
   e. Pressure test valve/seating to one and a half (1-1/2) times design operating pressure for 24 hours. MD ANDERSON representative shall witness this test.
   f. Upon passing pressure test and prior to hot tapping pipe:
      1) Verify that MD ANDERSON has staff ready to perform emergency shut-off procedures.
      2) Verify emergency patch is on location and sized to match pipe being tapped.
      3) Verify cleaning company is on call with portable shop vacuum(s).
   g. Hot tap pipe, remove plug and wire to valve handle.
   h. Clean all strainers in pipes affected by hot taps made that day.
   i. Reinsulate pipe.
   j. Repeat above listed steps for all remaining taps.

D. Unless approved by Owner all hot taps in horizontal lines shall be made at or above center line of pipe.

3.06 TRAINING
   A. Victaulic Company shall provide on-site training for Contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved end couplings. The manufactures representative shall periodically visit the jobsite and provide the contractor information concerning the best recommended practices in grooved product installation. A distributor's sales representative is not considered qualified to conduct the training or jobsite visit(s).
3.07 APPLICATION

A. Install valves and unions at equipment connections. Install unions on equipment side of valves. Provide dielectric isolation only where non-ferrous components connect to ferrous components.

B. Provide EPDM gasket material with a maximum service temperature of 120 degrees C at all hot water dielectric union installations.

C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

D. Install ball valves in piping 3 inches and smaller and butterfly valves in piping 4 inches and larger for shut-off and to isolate equipment, parts of systems, or vertical risers.

E. Install ball valves in piping 2 inches and smaller and butterfly valves in piping 2-1/2 inches and larger for throttling, bypass or manual flow control services. Under this application, throttling valves are not to be used for shutoff, and additional valves shall be installed for isolation.

F. Use plug valves for throttling service where indicated on Drawings.

G. Provide gate or ball drain valves at main shutoff valves, low points of piping, bases of vertical risers and at equipment. Pipe to nearest drain.

3.08 FLUSHING AND CLEANING OF PIPING SYSTEMS

A. MD ANDERSON Systems:

1. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the piping systems in service. Provide whatever temporary connections are required for cleaning, purging and circulating fluids through the piping system.

2. On completely new piping system installations, the contractor shall use temporary strainers and temporary pumps that can create fluid velocities up to 10 ft / sec if necessary to flush and clean the piping systems. Do not use Owner's permanent strainers to trap debris during pipe flushing operations. Fit the temporary construction strainers with a line size blowoff valve.

3. When constructing minor piping modifications or additions verify with Owner if the Owner's pumps and strainers can be used for flushing and chemical cleaning operations. When the flushing and cleaning operations are complete, the contractor shall insure the strainer baskets and screens installed in the piping systems permanent strainers replaced with clean elements. Keep temporary strainers in service until the equipment has been tested, then replace straining element with a new strainer and clean and deliver the old straining elements to Owner. Fit the Owners strainers with a line size blowoff valve.

4. Install bypass piping or hoses at the supply and return piping connections at heat exchangers, chillers, cooing towers, pumps and cooling coils, etc, to prevent debris from being caught or causing damage to equipment which will be connected to the piping system.
5. Circulate a chemical cleaner in chilled and heating water as well as condenser and generator cooling piping systems to remove mill scale, grease, oil and silt. Circulate Betz Entec 323 detergent with Betz Entec 234 antifoam compound. Circulate for 48 hours, flush system and replace with clean water. Dispose of chemical solution in accordance with local codes. The chilled and heating water system should then be treated with Betz Entec 338, nitride borate, 350 ppm as nitride with MBP inhibitor. When the chemical cleaning is complete, remove, clean and reinstall all permanent screens. Contractor shall notify Owner so that the reinstallation of clean strainer screens may be witnessed.

B. TECO System Requirements:

1. Cleaning: It is imperative to ensure that all piping or equipment connected to the TECO chill water system has been thoroughly cleaned to removed oils, dirt and other foreign materials.
   a. Make certain the new system is properly isolated from the TECO chilled water system.
   b. Using clean potable water, fill the system piping and add 1 to 2 percent (based on volume) of Tetra-Potassium Pyro Phosphate (TKPP) solution to the new system.
   c. Circulate for at least three (3) hours. During circulation maintain the maximum flow rate through the piping and equipment (target a minimum flow velocity of 3 feet per second).
   d. The addition of the TKPP will cause the pH in water to rise. Neutralize the pH by flushing with potable water. Continue to flush the system until the circulating water quality is consistent with potable water.
   e. Begin the passivation procedure immediately. DO NOT allow the water in the system to stand longer than two (2) hours before starting the passivation procedure.

2. Passivation: Contact TECO at the following address to obtain the latest passivation specification requirements:
   a. Contact: Steve Lehr, Thermal Energy Corporation (TECO), Supervising Senior Project Manager,
   b. Address: 1615 Braeswood, Houston, Texas 77030.
   c. Phone number: 713-791-6731.

3. Before TECO will provide thermal services to the Project, the following is required:
   a. Chilled Water System:
      1) A copy of an approved certified flushing report that the system is clean.
      2) TECO personnel to take a minimum of three samples from drains and test for iron (1.0 ppm is acceptable).
      3) The building pipe must be full of clean water without chemicals of any type.
4) All metering devices to be installed and Contractor supplied 20-amp, 3-wire circuit connected.

5) If the piping system is not filled with TECO chilled water immediately after testing, test must again be taken prior to providing services.

b. Quality Assurance: Provide only chemical products which are acceptable under state and local pollution control regulations.

3.09 WELDING

A. Scope: This article applies to welded chilled and heating water piping fittings and other appurtenances.

1. Piping and fittings shall be welded and fabricated in accordance with the latest edition of ASME/ANSI the latest editions of Standards B31.9 for all systems. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal.

   a. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal.

   b. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process.

   c. All pipe shall have the ends beveled 37-½ degrees and all joints shall be aligned true before welding.

   d. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction is not permitted.

3. Align piping and equipment so that no part is offset more than 1/16-inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

4. No weld shall project into 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.

5. Remove all split, bent, flattened or otherwise damaged piping from the Project Site.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. Schedule 40 pipe shall not be welded with less than three (3) passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four (4) passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.
END OF SECTION 23 21 13
SECTION 23 21 30 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
   B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY
   A. Perform all Work required to provide and install air vents, pressure gauges, thermometers, strainers, air separators, expansion tanks, relief valves, water flow measuring and balancing systems, and water flow integrating meters as indicated by the Contract Documents with supplementary items necessary for their proper installation and operation.

1.03 REFERENCE STANDARDS
   A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
   B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
   C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
      1. ANSI/ASME Boilers and Pressure Vessel Code, Section VIII, Division 1 Design and Fabrication of Pressure Vessels.

1.04 QUALITY ASSURANCE
   A. Manufacturer: For each product specified, provide components by the same manufacturer throughout.

1.05 SUBMITTALS
   A. Product Data:
      1. Submit Shop Drawings and product data, including component sizes, rough-in requirements, service sizes, and finishes.
      2. Submit manufacturer's installation instructions.

1.06 EXTRA MATERIALS
   A. Refer to Section 01 78 46 for Maintenance Material Requirements.
PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Expansion Tanks: Bell & Gossett, Taco, C. Adamson, Woods.
B. Automatic Air Vents: Armstrong.
C. Air Separators: Bell & Gossett, Taco, P. Wood, Armstrong.
D. Water Relief Valves: Keckley, Watts, Bell & Gossett.
F. Coil Package Valve Sets: Nexus, Tour and Anderson
G. Integrating Flowmeters: Panametrics, Balance Master, Controlotron, EMCO.
J. Pump Suction Fittings: Bell and Gossett, Taco, Victaulic, Anvil.

2.03 EXPANSION TANKS

A. Tank Construction: Closed, welded steel, tested and stamped in accordance with Section VIII, Division 1, of ANSI/ASME Boiler and Pressure Vessel Code, 125 psig rating. Clean, prime coat, and supply with steel support saddles. Supply with renewable heavy duty butyl rubber bladder. Construct tank with tappings for installation of accessories.
B. Provide with quick connect air charging valve connection (standard tire valve) tank drain.
C. Provide automatic cold water fill assembly complete with pressure relief valve, pressure reducing valve and valved bypass.
D. Set expansion tank pressure relief valve and pressure reducing valve at pressures indicated on Drawings.
E. Tank dimensions are as scheduled on Drawings.

2.04 AUTOMATIC AIR VENTS

A. Provide air vents at the highest points of the hydraulic piping systems and on the uppermost connections to all hydraulic coils; 125 psig pressure rating. Provide shutoff valves to facilitate maintenance of air vents.
B. Locate all air vents and their discharge lines in accessible locations, preferably clustered.
C. Route discharge lines to nearest floor drain without air traps.

2.05 AIR SEPARATORS
A. Steel tank, flanged inlet and outlet connections, separate top fittings for make-up line connection, automatic air vent, and bottom connection for blow-down and cleaning. ASME construction and stamped for 125 psig design pressure.
B. Provide stainless steel strainer with 3/16 inch diameter perforations and total free area of not less than five (5) times the cross sectional area of the connecting pipe.
C. Units shall be full line size.

2.06 WATER RELIEF VALVES
A. Pressure relief valves installed for the protection of the water circulating circuits shall be single seated diaphragm and spring type valve with screwed connections, similar to Watts No. 174A.
B. ¾ inch size of bronze construction with bronze seat, composition shut-off disc, and rubber diaphragm.

2.07 COIL CIRCUIT BALANCING VALVES
A. Install in chilled and hot water piping systems and elsewhere where shown on Drawings per manufacturer’s recommendation and installation instructions. Balance valves shall not be required on systems provide with pressure independent control valves. Balance valves shall be rated to operate and perform their intended design function at the system’s operating temperature and maximum design pressure. The valve body shall be a wye pattern, globe-style, and provide two pressure/temperature metering ports (PT Ports), and digital handwheel. Balancing valve handle shall have a integral memory stop for locking the valve position after the system is balanced.
B. Valves may also be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 1/4” threaded brass metering ports and gasketed caps located on the inlet side of the valve.

2.08 COIL PACKAGE VALVE SETS
A. Install per manufacturers recommendations and instructions on hot water terminal coils with automatic flow control Valves from ½ inch thru 2 inch: valve bodies shall be manufactured from brass ASTM B 283 capable of working at a maximum temperature of 370 F. at a pressure of 600 psi. The valve body is a Y type with cartridge set capable of working and maintaining flow rate at a differential pressure range between 2 to 45 psi.
B. Valves shall be furnished with precision machined cartridge orifice to provide automatic flow balancing. The valve shall have a blow down valve to clear fine particulate from the cartridge, and two, 1/4” threaded brass ports located on the inlet side of the valve use to acquire a differential pressure measurement. The ports shall have caps with O-ring seals.
C. In lieu of automatic flow control valves, Tour and Anderson STAP differential pressure controllers may be installed in conjunction with preset standard TA valves and coil components. Supply side coil package shall including a ball valve Y strainer combo with PT port, union, and blow down. Return side coil package shall include a union port fitting with PT port, manual air vent, union, and male threaded tail piece as well as the TA balancing valve. STAP shall be installed per manufacturer’s recommendations and at the locations shown on drawings with a partner TA valve adjacent on the supply line for capillary connection.

D. Systems provided with pressure independent control valves shall not require automatic or manual balancing valves.

2.09 INTEGRATING FLOWMETERS

A. General:

1. Install in main building chilled and hot water piping systems and elsewhere as shown on the Drawings.

2. Integrating flowmeters must have the following characteristics:
   a. Uses the transit-time principle of ultrasonic flow metering.
   b. Flow sensors that are portable, clamp-on type and that do not come in contact with the fluid or protrude into the flow path.

3. Flow element shall be installed in a straight run of pipe in accordance to manufacturer’s guidelines for the specific installation in order to maintain rated accuracy.

B. Flow Stations:

1. Flow stations shall consist of dual flow sensors and carriers mounted in the transverse arrangement with laminated or metal identification tag on chain giving pipe size, meter series, and station identification.

2. Maximum fluid operating ranges:
   a. Pressure: 0 to 150 psig.
   b. Temperature: 32 degrees F to 250 degrees F.

3. Flow stations shall be of steel construction.

C. Flow Meter:

1. Provide a hand-held, portable meter that instantaneously displays flow and/or changes in flow by means of a high-visibility, integral, backlit LCD, dual channel (one for chilled water, the other for steam condensate or hot water as noted on Drawings) that displays instantaneous flow rate in GPM and total gallons. Charts and tables are not acceptable.

2. Each channel shall have dual outputs for each of the displayed values. Outputs shall be 4–20 mA and TTL pulse rate, each proportional to display values.

3. Meter shall have positive zero flow indication.
4. Meter shall be complete with adequate lengths of flow cables attached to sensors, with installation and operating instructions.

5. Meter shall be capable of interfacing with and delivering a signal to the building automation system.

2.10 FLEXIBLE HOSE

A. Furnish and install Amber-Booth Metalflex flexible hose connectors or accepted substitution. Hose and braid shall be bronze and male fittings shall be steel.

B. Install connector in a straight line without offset. Piping shall be supported so that connector does not carry pipe load.

C. Install in line without twisting connector.

D. For pipe sizes ½ inch to 2 inches only. Model BR-SM.

2.11 PRESSURE GAUGES

A. Application: Provide pressure gauges as indicated on Drawings; 4-½ inch face diameter with 0.5 percent accuracy of full span, Grade 2A, ANSI B40.1.

B. Gauge Ranges:

1. Provide 0 - 160 psi gauges for 150 psi chilled/hot water service.

2. Provide 0 – 300 psi gauges for 300 psi, chilled/hot water service.

3. Provide 0 - 200 psi gauges for domestic cold water service.

4. Provide 0 – 150 psi gauges for condenser water and generator cooling water service.

5. Provide liquid glycerin filled compound pressure gauges with a graduation ratio of 30 psi to 30 inches of mercury across basket strainer at suction of condensing water pump.

C. For each gauge, provide bronze gauge lock and globe type bleed valve:

1. Similar to Jenkins 750, Crane 362E, Stockham B-66, Powell 120 or accepted substitution of the pressure rating for the system installed.

2.12 THERMOMETERS

A. Placement: Provide, where shown on Drawings and as indicated below, thermometers of suitable range for the service required. Provide thermometers on the inlet and outlet sides of all coils, heat exchangers, and heat generators.

B. Furnish thermometers for services in the following ranges and divisions with English scales:

1. Domestic hot water:

   a. Range: 30 to 200 degrees F.

   b. Division: 1 degrees F.
2. Heating hot water and generator cooling water:
   a. Range: 30 to 240 degrees F.
   b. Division: 2 degrees F.

3. Chilled water:
   a. Range: 0 to 100 degrees F.
   b. Division: 1 degree F.

4. Condenser water:
   a. Range: 0 to 120 degrees F.
   b. Division: 1 degree F.

C. Sockets: Provide thermometer sockets at all thermometer locations. Provide thermometer sockets only, fitted with plug and chain and conforming to the requirements specified for thermometers. Install all sockets vertical or at a 45-degree vertical angle to permit filling with conducting liquid for tests.

D. Construction: Provide thermometers that are 9 inches long with an etched glass enclosed scale of 2-degree increments, a cast aluminum case, and red reading mercury. Furnish an adjustable, angle-type scale with a swivel nut connection into ¾-inch brass separable sockets. Use a 3-1/2 inch stem length for all pipe sizes up through 8 inches, a 6-inch stem length for 10 inch pipe size, and a 9-inch stem length for pipe sizes larger than 10 inches.

E. Extensions: Where thermometers are installed in insulated lines, use extension-neck separable sockets.

F. Remote Thermostats: Furnish remote bulb thermometers where specified and shown. Provide thermometers with corrosion-resistant movements set in cast aluminum cases with black enamel finish.
   1. Furnish dials 4-½ inches in diameter, with black numbers on white dials.
   2. Use copper capillary tubing protected by a spiral or double-braided bronze armor.

2.13 PUMP SUCTION FITTINGS

A. Fitting: Angle pattern, cast iron body, flanged for over 2 inches, rated for 125 psig working pressure with inlet vanes, cylinder strainer with 3/16-inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

B. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping inside.

C. Provide mated flanges at all pump suckons.
2.14 STRAINERS

A. 2 inches and smaller: Screwed brass or iron body, Y pattern with 1/32 inch stainless steel perforated screen. 150 psi or 300 psi pressure rating to match system pressure.

B. 2-1/2 inches to 4 inches: Flanged iron body, Y pattern with 3/64 inch, screen body to be all 304/316 stainless steel construction and SS perforated screen with internal supports resistant to high differential pressure. 150 psi or 300 psi pressure rating to match system pressure.

C. Over 4 inches: Flanged iron body, basket pattern with 1/8 inch, screen body to be all 304/316 stainless steel construction and SS perforated screen with internal supports resistant to high differential pressure. 150 psi or 300 psi pressure rating to match system pressure.

PART 3 - EXECUTION

3.01 PREPARATION

A. Flush and clean expansion tanks prior to delivery to the Project Site, and keep sealed during construction.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Support expansion tanks from building structure in accordance with manufacturer’s instructions.

D. Provide automatic air vents at system high points and as indicated.

E. Provide manual air vents at entrance to all heating hot water coils, with a "cane" shaped discharge tube, positioned to permit draining to a portable receptacle.

F. For automatic air vents in above-ceiling spaces or other concealed locations, extend vent tubing to nearest drain.

G. Provide air separator on suction side of system circulation pump and connect as shown on Drawings.

H. Provide valved drain and hose connection on strainer blow down connection.

I. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.

J. Support pump fittings with floor mounted pipe and flange supports.

K. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
L. Select system relief valve capacity so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

M. Pipe relief valve outlet to nearest floor drain.

N. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

O. Install all pressure gauges so that they are easily readable.

P. Provide glycerin-filled compound pressure gauge upstream and downstream of each strainer.

Q. Provide liquid glycerin-filled gauges across all pumps and air compressors of ranges indicated above. This does not include control air compressor.

R. Pressure gauges need not be furnished across in-the-line circulators. Where air compressors and receivers are for control air only, standard 2-inch instrument gauges will be acceptable. Equip stem gauges with coil siphons.

S. Valve bodies and/or piping components that meet ISO 6509 and ASTM B858 made with dezincification resistant brass alloy designated with acronym (DZR) do not require dielectric unions on piping installations with dissimilar metals.

END OF SECTION 23 21 30
SECTION 23 31 00 – DUCTWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Provide materials and installation for complete first class HVAC systems; install ductwork, flexible duct, hangers, supports, sleeves, flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any supplementary items necessary for proper installation that make the systems operable, code compliant and acceptable to the authorities having jurisdiction.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASHRAE - Handbook of Fundamentals; Duct Design.
2. ASHRAE - Handbook of HVAC Systems and Equipment; Duct Construction.
3. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
5. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
6. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
7. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
8. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
10. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

12. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements.

13. SMACNA – HVAC Duct Construction Standards.


15. SMACNA – Round Industrial Duct Construction Standards.


17. UL 181 - Factory-Made Air Ducts and Connectors.


19. Assembly and Installation of Spiral Ducts and Fittings, UMC.

20. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.


1.04 INSTALLER QUALIFICATIONS:

A. Company shall have minimum three years documented experience specializing in performing the work of this section.

B. Installation of HVAC systems shall be performed by qualified Journeyman.

1.05 DEFINITIONS

A. Low Pressure

1. 2 inch W.G. Pressure Class: Ductwork systems up to 2 inch w.g. positive or negative static pressure with velocities less than or equal to 1500 fpm.

B. Medium Pressure

1. 3 inch W.G. Pressure Class: Ductwork systems over 2 inch w.g. and up to 3 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.

2. 4 inch W.G. Pressure Class: Ductwork systems over 3 inch w.g. and up to 4 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.

3. 6 inch W.G. Pressure Class: Ductwork systems over 4 inch w.g. and up to 6 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.

C. High Pressure

1. 10 inch W.G. Pressure Class: Ductwork systems over 6 inch w.g. and up to 10 inch w.g. positive or negative static pressure with velocities greater than 2500 fpm.
1.06 SUBMITTALS

A. Product Data:

1. Provide the following information for each sheet metal system furnished on the Project:
   a. System name and type.
   b. Duct system design pressure.
   c. Duct material.
   d. Duct gage.
   e. Transverse joint methods.
   f. Longitudinal seam type.
   g. Sealant type.
   h. SMACNA rectangular reinforcement type.
   i. SMACNA intermediate reinforcement type.
   j. SMACNA transverse reinforcement type.

B. Record Documents:

1. Submit Shop Drawings on all items of ductwork, plenums, and casings including construction details and accessories specified herein in accordance with Division 01. Ductwork construction details and materials used for duct sealant, flexible connections, etc. shall be submitted and approved prior to the fabrication of any ductwork.

2. Shop Drawings are required: Prepare Shop Drawings for the purpose of coordination with other trades including structural, piping, plumbing, electrical, lighting, and architectural. When Shop Drawings are not required to be submitted for the Project, field sketches and shop tickets must be available to the Owner upon request. Changes required during construction to accommodate coordination issues will be performed at no additional cost to the Owner.

3. Draw ductwork Shop Drawings on minimum 1/4 inch equal to one foot scale building floor plans and shall indicate duct sizes, material, insulation type, locations of transverse joints, fittings, ductwork bottom elevation, offsets, ductwork specialties, fire and fire/smoke dampers, and other information required for coordination with other trades. Clearly designate the following on the Shop Drawings:
   a. Clearance dimensions between ducts and or location dimensions from walls, floors, columns, beams and large bore piping.
   b. Duct materials i.e., stainless steel, galvanized steel, prefabricated fire rated ductwork pressure class ratings of ducts as defined within this specification.
   c. Duct materials i.e., stainless steel, galvanized steel, prefabricated fire rated ductwork.
d. Fire and fire/smoke partitions.

4. Detail Drawings for mechanical rooms and air handling unit locations shall be submitted at a minimum scale of 1/4 inch equal to one foot shall also be included within the Shop Drawings.

5. Coordinate with all other trades and building construction prior to submitting Shop Drawings for review. Indicate location of all supply, return, exhaust, and light fixtures from approved reflected ceiling plans on Shop Drawings.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the Project Site and store and protect products under provisions of Division 01 and Division 20.

B. Protect materials from rust both before and after installation.

1.08 WARRANTY

A. All ductwork shown on the Drawings, specified or required for the air conditioning and ventilating systems shall be constructed and erected in a first class workmanlike manner.

B. The Work shall be guaranteed for a period of one (1) year from the Project Substantial Completion date 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 Owner at Contractor’s expense.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 APPLICATION

A. Ductwork systems shall be constructed in accordance with the following Materials as a minimum standard. Refer to Drawings for any deviation from this Table.

<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>MATERIAL</th>
<th>MINIMUM PRESSURE CLASSIFICATION (1)</th>
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<tbody>
<tr>
<td>Supply and Return Systems:</td>
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<tr>
<td>Untreated Outside Air Intake (Louver) to AHU Plenum</td>
<td>304 Stainless Steel</td>
<td>Low Pressure</td>
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<td>Treated Outside Air to AHU</td>
<td>Galvanized Steel</td>
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<tr>
<td>Single Zone FCU Supply</td>
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<td>Single Zone AHU Supply</td>
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<td>Mixed Air (AHU Plenum)</td>
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<tr>
<td>AHU Discharge/Vertical Supply Riser</td>
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<tr>
<td>Vertical Supply Riser to Terminal Unit</td>
<td>Galvanized Steel</td>
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<tr>
<td>Terminal Unit Connection</td>
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<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>MATERIAL</th>
<th>MINIMUM PRESSURE CLASSIFICATION (1)</th>
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<tr>
<td>Terminal Units to Supply Air Device</td>
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<td>Vivarium Supply Air Valve to Air Device</td>
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<td>Return Air Device to Return Distribution</td>
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<td>Return Air Distribution</td>
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<td>Return Air Distribution/Vertical Riser</td>
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<td>Ductwork in MRI Rooms</td>
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<td>Exhaust Systems:</td>
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<td>Exhaust Air Device to Exhaust Distribution</td>
<td>Galvanized Steel</td>
<td>Low Pressure</td>
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<td>Exhaust Air Distribution</td>
<td>Galvanized Steel</td>
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<tr>
<td>General Exhaust Vertical Riser to Fan</td>
<td>Galvanized Steel</td>
<td>Medium Pressure</td>
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<tr>
<td>Kitchen Hood Exhaust</td>
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<tr>
<td>General Lab Exhaust Air Device to Horizontal Distribution</td>
<td>Galvanized Steel</td>
<td>Low Pressure</td>
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<tr>
<td>Hood/Biosafety Cabinet Exhaust to Horizontal Distribution</td>
<td>316L Stainless Steel</td>
<td>Medium Pressure</td>
</tr>
</tbody>
</table>

B. Notes to Table:

1. Positive pressure unless noted otherwise in Table.

2. Air device connections may be made with insulated flexible duct as specified herein.

3. Verify minimum pressure classification per NFPA 96 requirements.

4. Applies to exhaust system for general laboratory exhaust, fume hoods, and biosafety cabinets. Refer to Drawings for construction of any additional exhaust systems.

5. Where ductwork systems are subject to routine decontamination (HPV, Clidox, etc.), provide 316L stainless steel ductwork as indicated.

2.03 DUCTWORK MATERIAL AND CONSTRUCTION

A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein.

B. Ductwork shall be constructed of G-90 coated galvanized steel of ASTM A653 and A924 Standards.

C. Minimum gage of round, oval or rectangular ductwork shall be 26 gage per SMACNA Standards.

D. All duct sizes shown on the Drawings are clear inside dimensions. Allowance shall be made for internal lining, where specified, to provide the required free area.
E. 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 future connections/phases, otherwise plastic covers are acceptable.

F. Except for specific duct applications specified herein, all sheet metal shall be constructed from prime galvanized steel sheets and/or coils up to 60 inches in width. Each sheet shall be stenciled with manufacturer's name and gage.

G. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."

H. Where ducts are exposed to view (including equipment rooms) and where ducts pass through walls, floors or ceilings; furnish and install sheet metal collars around the duct.

I. Spin-in fittings shall be as specified under Section 23 33 00 – Ductwork Accessories.

J. Duct Sealing: All ductwork, regardless of system pressure classification, shall be sealed in accordance with Seal Class A, as referenced in SMACNA Standards. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.

1. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3 inches wide open weave fiberglass scrim tape. Sufficient additional sealant shall then be applied to completely embed the cloth.

2. Sealant shall be water based latex UL 181A-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be Hard Cast Iron Grip 601, Ductmate Pro Seal, Foster 32-19, Childers CP-146 or Design Polymerics DP 1010.

3. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count, similar to Hardcast FS-150.

4. Sealer shall be rated by the manufacturer and shall be suitable for use at the system pressure classification of applicable ductwork.

5. Except as noted, oil or solvent-based sealants are specifically prohibited.

6. For exterior applications, “Uni-Weather” (United McGill Corporation), solvent-based sealant, or Foster 32-19 shall be used.

2.04 RECTANGULAR AND ROUND DUCTWORK

A. Metal gages listed in SMACNA HVAC Duct Construction Standards, Metal and Flexible Duct, are the minimum gages which shall be used. Select metal gage heavy enough to withstand the physical abuse of the installation. In no case shall ductwork be less than 26 gage per SMACNA Standards.

B. All longitudinal seams for rectangular duct shall be selected for the specified material and pressure classification. Seams shall be as referenced in SMACNA Standards.

C. Longitudinal seams in laboratory hood exhaust ducts shall be welded.
D. All transverse joints and intermediate reinforcement on rectangular duct shall be as shown in SMACNA Standards. Transverse joints shall be selected consistent with the specified pressure classification, material, and other provisions for proper assembly of ductwork.

E. Spiral round duct and fittings shall be as manufactured by United McGill Sheet Metal Company or approved equivalent. All fittings shall be factory fabricated, machine formed and welded from galvanized sheet metal.

F. Joints in spiral duct and fittings shall be assembled, suspended, sealed, and taped per manufacturer’s published assembly and installation instructions.

G. Contractor may use DUCTMATE or Ward Industries coupling system, as an option, on rectangular ductwork. The DUCTMATE or Ward Industries system shall be installed in strict accordance with manufacturer’s recommendations.

H. Rectangular ductwork field fabricated offsets shall not exceed 30 degrees.

2.05 FLAT OVAL DUCTWORK AND FITTINGS

A. Oval ducts shall be spiral flat oval or welded flat oval equivalent to those of United McGill Sheet Metal Company with gage and reinforcing as recommended by the manufacturer. Duct may be shop fabricated of completely welded construction in accordance with SMACNA Standards.

B. Oval ducts greater than 24 inch x 72 inch shall be longitudinal seam, flat oval duct, rolled, welded and provided in standard lengths of 5 and 10 feet. Transverse joints shall be factory welded or field connected with flanges or slip couplings. Duct will be fabricated from galvanized steel meeting ASTM A 527 standards.

C. Duct reinforcing angles shall be of sizes specified for same size rectangular duct. Galvanized angles shall be used where standing seams are specified for rectangular duct.

D. Oval fittings shall comply with requirements, sealing, etc., similar to that specified for round ductwork. Manifolding taps may be permitted without increasing the length of run in the branch duct system.

E. Elbows in oval ducts may be smooth long radius or 5-piece 90-degree elbows and 3-piece 45-degree elbows. Joints in sectional elbows shall be sealed as specified for duct sealing.

2.06 CONICAL BELLMOUTH FITTINGS AND TAPS

A. Conical bellmouth fittings shall be made from 26-gage G-90 coated galvanized steel. Two-piece construction with a minimum overall length of 6 inches and factory sealed for high-pressure requirements. Average of loss coefficient for sizes 6, 8 and 10 shall be less than 0.055.

B. Provide each fitting with minimum 24-gage damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper form rotating around shaft. Shaft shall be extended to clear insulation.

C. Provide a flange and gasket with adhesive peel-back paper for ease of application. The fittings shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on center with a minimum of four (4) screws per fitting.
D. Conical bellmouth fittings shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc. or Buckley Air Products, Inc., “AIR-TITE”.

2.07 CASINGS AND PLENUMS - 2 INCH W.G. PRESSURE CLASS

A. All 2 inch w.g. pressure class casings and plenums for mixed air plenums shall be constructed in accordance with SMACNA Standards.

B. All casings shall enclose the filter and automatic dampers as shown on the Drawings. Casings shall be fabricated of galvanized sheet metal erected with three-foot center maximum standing seams reinforced with ¼-inch bars. The casing shall be stiffened on three-foot centers maximum with angle irons tack welded in place.

C. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be installed as indicated on the Drawings and shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches and #370 hinges that can be operated from both the inside and the outside.

D. Casings shall be anchored by the use of angle irons sealed and bolted to the curb and floor of the apparatus casing. Casings shall be tested and provided tight at a pressure of three inches water column.

E. Insulate per Section 23 07 13.

2.08 CASINGS AND PLENUMS – 6 INCH W.G. PRESSURE CLASS

A. Shall enclose filters and automatic dampers at air handling unit systems. Casings shall be constructed of cellular, standing seam panels with 3 inch deep reinforced “hat” sections as manufactured by metal deck manufacturers and as described in SMACNA Standards.

B. All openings to the casing shall be properly sealed to prevent air leakage. Install access doors for easy access to equipment. Access doors shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches that can be operated from both the inside and outside. Hinges shall be equivalent to Ventlok #370.

C. Anchor casing by the use of galvanized angle irons sealed and bolted to the curb and floor of the apparatus casing as indicated in SMACNA Standards.

D. A fan discharge diffuser plate shall be located on the fan discharge and shall be constructed of 10 gage steel perforated plate installed in 6 inch channel iron frames (8.2#) rigidly supported to withstand the fan discharge velocity. Perforations shall be 3/8 inch (0.375 inch) staggered on 11/16 inch centers (27 percent open area). One section shall be hinged to provide an access door between the discharge side of the fan and the entering side of the coils. After fabrication of the diffuser plate, coat with rust-resistant paint. After installation, touch up diffuser plate and paint channel iron frames with rust-resistant paint.

E. Provide sufficient access openings to allow access for maintenance of all parts of the apparatus. Access door size shall be as large as feasible for the duty required.

F. Insulate per Section 23 07 13.
2.09 ELBOWS RECTANGULAR DUCTS

A. Construct elbows as follows in order of preference:
   1. Long radius, unvaned elbows.
   2. Short radius, single thickness vaned elbows.
   3. Rectangular, double thickness vaned elbows.

B. Long radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width. Short radius elbows shall have a centerline radius of not less than one times the duct width.

C. Contractor shall have the option to substitute short radius vaned elbows, but shall request the substitution at the time of submittal of Product Data.

D. Provide turning vanes in all rectangular elbows and offsets.

E. Job fabricated turning vanes, if used, shall be fabricated of the same gage and type of material as the duct in which they are installed. Vanes must be fabricated for same angle as duct offset. Submit Shop Drawings on factory fabricated and job fabricated turning vanes.

F. All turning vanes 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.

G. In 90-degree turns that are over 12 inches wide in the plane of the turn, provide and install double thickness vanes on integral side rails. For ducts under 12 inches in width, use single thickness vanes. The installation of the turning vanes shall be as described for single thickness vanes. On other types of turns or elbows, single thickness trailing edge vanes shall be used.

2.10 FLEXIBLE DUCT

A. Flexible duct shall be used where flexible duct connections are shown on the Drawings to air distribution devices and terminal units and as scheduled under “Ductwork System Applications.

B. Acoustical Flexible Duct to Diffusers, Grilles, and Terminal Units:
   1. Maximum flex duct length 6’-0” (six feet), installed with no more than 90 degrees of bend to diffusers and grilles. Where longer duct runs or more bends are necessary, provide rigid round ductwork.
   2. Maximum flex duct length 2’-0” (two feet), installed as a straight run to the inlet of the terminal units.
   3. Acoustical flexible duct shall be manufactured with an acoustically rated CPE inner film as the core fabric, mechanically locked by a corrosion-resistant galvanized steel helix.
4. Core shall be factory pre-insulated with a total thermal performance of R-3.5 or greater. Outer jacket shall be a fire retardant polyethylene vapor barrier jacket with a perm rating not greater than 0.10 per ASTM E 96, Procedure A.

5. Duct shall be rated for a minimum positive working pressure of 6 inches w.g. and a negative working pressure of 4 inches w.g. minimum.

6. Temperature range shall be –20 degrees F to 250 degrees F.

7. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter’s Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread less than 25; smoke developed less than 50.

8. Acoustical flexible duct shall be similar to Flexmaster Type 8M for construction and acoustical performance standards.

C. Metal Flexible Duct:

1. May be used for terminal unit connections from sheet metal ductwork where shown on the Drawings.

2. Maximum length 2’-0” (two feet), installed in straight runs only. Where longer duct runs or direction changes are necessary, provide rigid round ductwork.

3. Duct shall be constructed of 0.005 inch thick 3003-H14 aluminum alloy in accordance with ASTM B209. Duct shall be spiral wound into a tube and spiral corrugated to provide strength and flexibility.

4. Core shall be factory pre-insulated with a total thermal performance of R-3.5 or greater. Outer jacket shall be fire retardant metalized vapor barrier jacket of fiberglass reinforced aluminum foil, with a permeance rating not greater than 0.05 per ASTM E96, Procedure A.

5. The duct shall be rated for a minimum positive and negative working pressure of 10 inch w.g.

6. Temperature range shall be –40 degrees F to 250 degrees F.

7. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter’s Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread less than 25; smoke developed less than 50.

8. Metal flexible duct shall be similar to Flexmaster triple lock Type TL-M.

2.11 STAINLESS STEEL DUCTWORK

A. Applies to general laboratory exhaust, fume hood, biosafety cabinet, radioisotope hood, vivarium supply and exhaust systems subject to routine decontamination (HPV, Clidox, etc.), and moisture exhaust systems where indicated on the Drawings and as specified herein.
B. Stainless steel shall be 316-L with welded longitudinal seams and welded transverse joints. Welds on exposed ductwork shall be positioned for minimum view and shall be ground and polished. Duct sealant shall not be used to seal this ductwork.

C. All ductwork risers shall be installed as vertical as possible within the constraints of the design indicated on the Drawings.

D. In all cases, ductwork shall be installed so that the washdown water, where installed, shall drain back to the hood.

E. Metal gages shall be not less than the following:

<table>
<thead>
<tr>
<th>DUCT SIZE</th>
<th>GAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-inch diameter or less</td>
<td>18</td>
</tr>
<tr>
<td>31-inch to 60-inch diameter</td>
<td>16</td>
</tr>
<tr>
<td>61-inch diameter or greater</td>
<td>14</td>
</tr>
<tr>
<td>Greater than 60 x 42 (rectangular or oval)</td>
<td>Comply with SMACNA</td>
</tr>
</tbody>
</table>

F. The joining of stainless steel ductwork with galvanized ductwork where indicated in the Drawings shall use ductwork construction methods specified herein for galvanized ductwork.

G. Connections to Air Devices Cabinets or Hoods:

1. Where approved by Owner, flexible stainless steel ducting can be used in lieu of hard pipe stainless steel at cabinets or hoods

2. For all non insulated duct applications flexible ducting shall be 316TI stainless steel; pressure rated for 12 inches w.g. positive and negative; UL 181, Class 0 air duct rated; Velocity Rated for 5500 fpm. Similar to Flexmaster Type SS-NI-TL.

3. For all insulated duct applications, flexible ducting shall be 316 stainless steel; pressure rated for 12 inches w.g. positive and negative; UL 181, Class 1 air duct rated; Velocity Rated for 5500 fpm. Similar to Flexmaster Type SS-TLM.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Cleanliness:

1. Before installing ductwork, wipe ductwork to a visibly clean condition.

2. During construction, provide temporary closures of metal or taped polyethylene on open ductwork and duct taps to prevent construction dust or contaminants from entering ductwork system. Seal ends of ductwork prior to installation to keep ductwork interior clean. Remove closures only for installation of the next duct section.
3. For ductwork supplying Clean Rooms, Operating Rooms and other Critical Care areas, sanitize ductwork with a biocidal agent EPA approved for HVAC systems immediately prior to sealing ductwork.

4. During duration of construction, maintain the integrity of all temporary closures until air systems are activated.

D. Provide openings in ductwork where required to accommodate thermometers, controllers and other devices. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring. Sleeve of pitot tube opening shall be no more than one inch long. Opening shall be one inch wide to accept pitot tube.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Slope underground ducts to plenums or low pump out points at 1:500. Provide access doors for inspection.

G. Coat buried, metal ductwork without factory jacket with one coat and seams and joints with additional coat of asphalt base protective coating.

H. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

I. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout. Use stainless steel for ductwork exposed to view and stainless steel for ducts where concealed.

J. All visible welds in ductwork between biosafety cabinets, canopy hoods and fume hoods and the ceiling shall be ground and polished.

K. Slope duct toward grilles for moisture-laden ducts. Provide drain and trap at elbow of main moisture exhaust duct system.

L. Project inspector shall be notified to inspect all field fabricated offsets before cover-up or external insulation is applied.

M. Flexible Duct:

1. The terminal ends of the duct core shall be secured by compression coupling or stainless steel worm gear type clamp.

2. Fittings on terminal units and on sheet metal duct shall have flexible duct core slipped over duct and coupling or clamp tightened, then connection sealed with sealant. Insulation of flexible duct shall be slipped over connection to point where insulation abuts terminal unit or insulation on duct.

3. These insulation connections shall be sealed by embedding fiberglass tape in the sealant and coating with more sealant to provide a vapor barrier.
N. Support flexible ducts as per SMACNA standards to prevent sags, kinks and to have 90 degree turns.

O. Hangers and Supports:
   1. All ductwork supports shall be in accordance with Table 4-1 (rectangular duct) and Table 4-2 (round duct) of the SMACNA Standards, with all supports directly anchored to the building structure.
   2. Rectangular duct shall have at least one pair of supports on minimum 8'-0" (eight feet) centers. All horizontal round and flat oval ducts shall have ducts hangers spaced 10'-0" (ten feet) maximum.
   3. Lower attachment of hanger to duct shall be in accordance with Table 4-4 of the SMACNA Standards.
   4. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2 inch x 1-1/2 inch x 1/4 inch angles for duct widths up to 60 inches. Above 60 inches in width, the angles must be increased in strength and sized on an individual basis considering space requirements.
   5. Hanger straps on duct widths 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the sides.
   6. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8 inch bolts minimum.

3.02 DUCTWORK SYSTEM CLEANING

A. If the system has been operated without scheduled filters or if the integrity of temporary closures has been compromised, Contractor shall have ductwork cleaned according to National Air Duct Cleaners Association (NADCA) Standards by a Certified Regular Member of the NADCA.

   1. For ductwork supplying Clean Rooms or patient care areas, also sanitize the ductwork interior per NADCA standards with a biocidal agent approved by the EPA for use in HVAC Systems.

B. Before turning the installation over to the Owner, Contractor shall certify that the air handling systems have only been operated with scheduled filters in place. Otherwise, Contractor shall present evidence that the ductwork was cleaned as required above.

3.03 TESTING

A. All medium and high pressure duct systems (positive or negative) shall be pressure tested according to SMACNA test procedures (HVAC Air Duct Leakage Test Manual). Notify Owner minimum seven (7) calendar days in advance of leakage testing.

   1. Design pressure for testing ductwork shall be determined from the maximum pressure generated by the fan at the nominal motor horsepower selected.
   2. Total allowable leakage shall not exceed 1 percent of the total system design airflow rate.
3. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

4. Leaks identified during leakage testing shall be repaired by:
   b. Thorough cleaning of the joint surfaces.
   c. Installation of multiple layers of sealing materials.

5. The entire ductwork system shall be tested, excluding connections upstream of the terminal units (i.e. ductwork shall be capped immediately prior to the terminal units, and tested as described above).

6. After testing has proven that ductwork is installed and performs as specified, the terminal units shall be connected to ductwork and connections sealed with extra care. Contractor shall inform the Owner when joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage exists in the terminal unit connections/joints after the systems have been put into service, leaks shall be repaired as specified for other leaks.

7. Fixed flow measurement devices (i.e. orifice tubes, nozzles, etc.) shall have current calibration documentation showing that the device was verified to a National Institute Of Standards and Technology (NIST) standard within the previous five years or as recommended by the manufacture and be accurate to at least +/- 2% of reading.

8. Pressure measurement instrumentation (i.e. manometer) shall have current calibration documentation showing that the device was verified to a NIST standard within the previous year or as recommended by the manufacture. Instrumentation shall have an accuracy of at least +/- 2% of reading and have a resolution of 2:1 with respect to the measured pressure (i.e. resolution of 0.01 measured 0.1).

B. All low-pressure duct systems (positive or negative) shall be inspected for visible and audible signs of leakage.

1. Leaks identified by inspection shall be repaired by:
   b. Thorough cleaning of the joint surfaces.
   c. Installation of multiple layers of sealing materials.

2. Discrepancies found during testing and balancing between duct traverses and diffuser/grille readings shall result in re-inspection, repair and retest until discrepancies are eliminated.

C. At the option of the Owner, if documented in writing, Contractor may be allowed to eliminate testing of terminal units by capping the supply ductwork prior to the terminal units, then inspecting the connection to the terminal units when complete. This option may only be exercised by the Owner, only if documented in writing prior to testing.

D. Ductwork leakage testing and/or inspection shall be performed prior to installation of external ductwork insulation.
END OF SECTION 23 31 00
SECTION 23 33 00 – DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install the following ductwork accessories indicated by the Contract Documents with supplementary items necessary for proper installation.

1. Airflow control dampers and spin-in fittings.

2. Fire dampers, smoke dampers, and combination fire and smoke dampers.

3. Flexible duct connections.

4. Duct access doors.

5. Screens

6. Duct test holes.

7. Guy wire systems.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. AMCA 500D – Laboratory Method of Testing Dampers for Rating.

2. AMCA 500L – Laboratory Method of Testing Louvers for Rating.


5. SMACNA - HVAC Duct Construction Standards.

8. UL 555C – Standard for Ceiling Dampers.

1.04 SUBMITTALS

A. Product Data:

1. Provide product data for shop fabricated assemblies including, but not limited to, volume control dampers, duct access doors, and duct test holes. Provide product data for hardware used.

B. Record Documents:

1. Fire Dampers: The damper manufacturer’s literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500D standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05-inch water gauge.

2. Combination Fire/Smoke Dampers: Assign identification numbers for each damper with corresponding number noted on Drawings. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper. Provide manufacturer’s data of damper and its accessories or options. At Owner’s request, provide two (2) dampers (18 inch x 12 inch) for the purpose of illustrating damper operation to Owner’s operating and maintenance personnel.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Dampers:

1. Greenheck.
2. Louvers and Dampers, Inc.
4. Prefco.
5. Ruskin.
6. Portorff

B. Regulators, Locking Quadrants:
1. Ventfabrics

2. Mercer Rubber

2.03 AIR FLOW CONTROL DAMPERS

A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of airflow, including all supply, return, outside air, and exhaust branches, "division" in main supply, return and exhaust ducts, and each individual air supply outlet. Where access to dampers through a permanent suspended ceiling (gypsum board) is necessary, the Contractor shall be responsible for the proper location of the access doors.

B. Dampers larger than three (3) square feet in area shall be controlled by a self-locking splitter damper assembly.

C. Volume damper blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16 gage galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.

D. Volume dampers and other manual dampers shall be carefully fitted, and shall be manually controlled by damper regulators as follows:

1. On exposed uninsulated ductwork the locking quadrant shall be made with a base plate of 16-gage cold-rolled steel and a heavy die cast handle designed with a 3/8 inch bearing surface. A 1/4 inch-20 zinc plated wing nut shall firmly lock the handle in place.

2. On exposed externally insulated ductwork the regulator shall be 4-1/4 inch diameter, for 1/2 inch rod, designed for use on duct with insulation thickness specified for duct, and shall have four (4) 3/16 inch holes provided to rivet or screw regulator to the duct surface. The flange that covers the raw edge of the insulation shall be high enough so that it slightly compresses the insulation and holds insulation in place. The handle shall be 3/8 inch above the flange, and shall easily turn without roughing up the insulation.

3. On concealed ductwork above inaccessible ceilings, the regulator shall be 2-5/8 inch diameter chromium plated cover plate that telescopes into the base, for 1/2 inch rod. Regulator shall be cast into a box for mounting in ceilings. Base shall be 1-1/2 inch deep. The cover shall be secured by two screws that can be easily removed for damper adjustment.

4. Furnish and install end bearings for the damper rods on the end opposite the quadrant.

E. Spin-in fittings may be used for duct taps to air devices and shall include dampers on all duct to air devices (diffusers and grilles) even though a volume damper is specified for the air device. Spin-in fittings shall be similar to Flexmaster FLD with BO3 including a 2 inch buildout, nylon bushings, locking quadrant similar to Duro Dyne KR-3, and a 3/8 inch square rod connected to the damper with U-bolts. Spin-in fittings shall be sealed at the duct tap with sealant as specified herein. Determine location of spin-in fittings after terminal units are hung or after location of light fixtures are confirmed to minimize flexible duct lengths and sharp bends.
2.04 FIRE DAMPERS

A. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555, latest edition. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating, 160 or 165 degrees F fusible link, and shall bear a U.L. label in accordance with Underwriters’ Laboratories labeling procedures. Construct fire dampers such that damper frame material and curtain material are galvanized.

B. Fire dampers shall be curtain blade type and damper shall be constructed so that the blades are out of the air stream to provide 100 percent free area of duct in which the damper is housed.

C. Equip fire dampers for vertical or horizontal installation as required by location shown on Drawings. Install fire dampers in wall and floor openings utilizing steel sleeves, angles and other material and practices as required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be minimum 1-1/2 inch by 1-1/2 inch by 14 gage and bolted, tack welded or screwed to the sleeve at maximum spacing of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the duct gage as defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6 inch water gauge static pressure.

D. All fire dampers shall be dynamic rated type.

E. Completely seal the damper assembly to the building components using manufacturer recommended material(s).

2.05 COMBINATION FIRE/SMOKE DAMPERS

A. Each combination fire/smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, Current Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class I (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4 inches water gauge pressure). Maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.) All ratings shall be dynamic.

B. Damper frame shall be minimum 20-gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. Dampers may be either parallel or opposed blade type. Blades shall be constructed with a minimum of 14-gage equivalent thickness. Blade edge seal material shall be able to withstand 450 degrees F. Jamb seals shall be flexible stainless steel compression type or lap seal type.
C. In addition to the leakage ratings specified herein, combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. Damper and operator shall be supplied as a single entity that meets all applicable UL555 and UL555S qualifications for both dampers and operators. Manufacturer shall provide a factory-assembled sleeve. Sleeve shall be minimum 20-gage for dampers where neither width nor height exceeds 48 inches or 16-gage where either dimension equals or exceeds 48 inches.

D. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.

E. Each combination fire/smoke damper, except as noted hereinafter, shall be equipped with a UL Classified firestat/releasing device. The firestat/releasing device shall electrically (24 VAC) and mechanically (pneumatically) lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. Damper must be operable while the temperature is above 350 degrees F. Actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm system, and remote indicating/control stations or building automation system (BAS).

F. Damper releasing device shall be mounted within the airstream. Device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.

G. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this Specification. Furnish all required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system.

H. Furnish each damper in a square or rectangular configuration. Furnish and install sleeves manufactured by the approved damper manufacturer for each damper. Construct sleeves with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturer’s U.L. installation instructions. The entire assembly, following installation, shall operate smoothly and be capable of withstanding 6 inch water gauge static pressure.

I. Each combination fire/smoke damper shall be equipped with a Damper Test Switch. The damper test switch will have the ability to “cycle test” the fire/smoke damper by pushing and holding the test button until the damper has cycled.

J. All combination fire/smoke dampers shall be dynamic type.
K. Completely seal the damper assembly to the building components using manufacturer recommended material(s).

2.06 SMOKE DAMPERS

A. Each smoke damper shall be dynamic rated type and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. Leakage rating under UL555S shall be no higher than Leakage Class I (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4 inches water gauge pressure). Maximum air pressure drop through each smoke damper shall not exceed 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.) All ratings shall be dynamic.

B. Damper frame shall be minimum 16ga galvanized formed into a structural hat channel shape with corner braces for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be stainless steel sleeve type turning in an extruded hole in the frame or an extruded frame raceway. Dampers shall be opposed blade type. Blades shall be airfoil shaped double skin construction. Blade edge seal material shall be silicone rubber designed to withstand 450 degrees F. Jamb seals shall be aluminum flexible metal compression type.

C. In addition to the leakage ratings specified herein, smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 350 degrees F. 120 VAC electric operators shall be installed by the damper manufacturer at the time of damper fabrication. Damper and operator shall be supplied as a single entity that meets all applicable UL555 and UL555S qualifications for both dampers and operators.

D. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed position, and 2000 fpm air velocity in the open position.

E. The damper must be operable while the temperature is above 350 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. Position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations (BAS).

F. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed by the damper manufacturer as required by the UL rating mentioned above. Motors shall be (electric) or (pneumatic) to match the type of temperature control system specified elsewhere in this Specification. Furnish all required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system.
G. Furnish each damper in a square or rectangular configuration. Furnish and install sleeves manufactured by the approved damper manufacturer for each damper. Construct sleeves with square or rectangular to square, rectangular, round, or oval adapters as required. Install dampers in the sleeves in accordance with manufacturer’s UL installation instructions. Entire assembly, following installation, shall operate smoothly and be capable of withstand 6 inch water guage static pressure.

H. Each smoke damper shall be equipped with a Damper Test Switch. The damper test switch will have the ability to “cycle test” the smoke damper by pushing and holding the test button until the damper has cycled.

I. All smoke dampers shall be dynamic type.

J. Completely seal the damper assembly to the building components.

2.07 FLEXIBLE CONNECTIONS

A. Where ducts connect to, flexible connections shall be made using “Flexmaster TL-M” or “Ventglas” fabric that is temperature-resistant, fire-resistant, waterproof, mildew-resistant and practically airtight, weighing approximately thirty ounces (30 oz.) per square yard. Ventglas is good for connections for inside building environments where ultra-violet light is not present.

B. Material used outdoors shall be resistant to ultra-violet sunrays. There shall be a minimum of one-half inch (1/2-inch) slack in the connections, and a minimum of two and one-half inches (2-1/2-inch) distance between the edges of the. This does not apply to air handling units with internal isolation. A more rugged flexible material that is resistant to ultra violet rays needs to be used when connecting an exhaust fan or exhaust air plenum to ductwork. Mercer Rubber supplies a more durable flex connection for outdoor use.

C. Connections to Chemical Fume Hoods

1. Flexible connections shall be made using a coupling with stainless steel bands as manufactured by Fernco, Inc.

2.08 ACCESS DOORS

A. Furnish and install in the ductwork, hinged rectangular, pressure relief, or round "spin-in" access doors to provide access to all fire dampers, mixed air plenums, steam reheat coils (install upstream), automatic dampers, etc.

B. Where ductwork is insulated, access doors shall be double skin doors with one inch (1") of insulation in the door.

C. Where duct size permits, doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors).

D. Latches for rectangular doors smaller than 18 inch x 16 inch shall be Ventlok No. 100 or 140.

E. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10 inch x 12 inch, complete with latch and two (2) hinges, or twelve inches (12") in diameter.
F. Round access doors shall be "Inspector Series" spin-in type door as manufactured by Flexmaster USA.

G. Grease duct access doors shall be as manufactured by Dura Systems Barriers Inc.

H. Doors for personnel access to ductwork shall be nominal twenty-four inches (24") in diameter. Doors may be fabricated in a local approved sheet metal shop in accordance with SMACNA Standards.

I. Where access doors are installed above a suspended ceiling, this Contractor shall be responsible for the proper location of ceiling access doors.

2.09 SCREENS

A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are located outdoors.

B. Screens shall be No. 16 gage, one-half inch (1/2") mesh in removable galvanized steel frame.

C. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.10 GUY WIRE SYSTEM

A. Provide 1/4-inch diameter American Aircraft Steel Cable (plastic coated) with clip for vertical stack off utility fans on roof, with eyebolts for attachment to anchor systems on the roof.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.

D. Provide all dampers furnished by the BAS Provider in strict accordance with manufacturer’s written installation instruction and requirements of these Specifications.

E. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

1. Instructions to A/E and Contractor:

   a. Fire dampers, smoke dampers and combination fire smoke dampers should not be installed where ducts pass through non fire/smoke rated architectural or structural components. Remove all fire and smoke dampers and combination fire smoke dampers from non-fire rated structural architectural or structural.
F. Provide backdraft dampers on exhaust fans or exhaust ducts where indicated. Install dampers so that they will open freely.

G. Flex connectors are not required at equipment with internally isolated fans. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps where noted on the Owner’s drawings.

H. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated on Drawings. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated.

I. Provide duct test holes where indicated and where required for testing and balancing purposes.
   1. Furnish and install Ventlok No. 699 instrument test holes in the return air duct and in the discharge duct of each fan unit.
   2. Install test holes in locations as required to measure pressure drops across each item in the system, e.g., outside air louvers, filters, fans, coils, intermediate points in duct runs, etc.

J. Access doors as specified elsewhere shall be provided for access to all parts of the fire and combination fire and smoke dampers. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.

K. Install each fire and combination fire and smoke damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555 and UL555S.

3.02 TESTING

A. After each fire damper, smoke damper and combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to installation of ceilings, Contractor shall, as directed by Owner, activate part or all dampers as required to verify “first-time” closure. The activation must be scheduled as part of the commissioning and witnessed by an institutional representative.

B. Activation of damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fire damper fusible link, and manually operating the fire/smoke damper through the pneumatic or electronic controls as appropriate.

C. Failure of damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.

D. Coordinate smoke damper system interlock requirements with the fire alarm system.

END OF SECTION 23 33 00
SECTION 26 01 00 - BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Drawings are necessarily diagrammatic by their nature and are not intended to show every connection in detail or every pipe or conduit in its exact location. Carefully investigate structural and finish conditions and coordinate the separate trades in order to avoid interference between the various phases of Work. Organize and lay out Work so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Install all Work parallel or perpendicular to building lines unless otherwise noted.

B. The intent of the Drawings is to establish the types of systems and functions; not to set forth each item essential to the functioning of the system. Install the Work complete, including minor details necessary to perform the function indicated. Review pertinent Drawings and adjust the Work to conditions shown. Where discrepancies occur between Drawings, Specifications, and actual field conditions, immediately notify the Owner’s Project Manager for Owner’s interpretations.

C. Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical, and plumbing Drawings. Review any proposed changes in electrical wiring devices or equipment location with the Owner’s Project Manager. Owner may direct relocation of outlets before installation, up to five (5) feet from the position indicated, without additional cost. Remove and relocate outlets placed in an unsuitable location when requested by the Owner, at no additional cost to the Owner.

D. All dimensional information related to new structures shall be taken from the appropriate Drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the Site.

E. Existing Structures: The building floor slabs, structure, and outer walls are generally existing to remain. The only existing penetrations are openings where indicated on the Drawings. This Contract requires the Contractor to core drill all other floor or wall penetrations as required. All floor penetrations shall include a sleeve that extends two (2) inches above the floor. Bus duct penetrations shall have a minimum 4-inch high curb as per NEC requirement or per drawing, whichever is higher.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the Contract Documents.

1.04 DEFINITIONS

A. Concealed: Concealed areas are those areas that cannot be seen by building occupants.

B. Exposed: Exposed areas are all areas that are exposed to view by building occupants, including areas below counter tops, inside cabinets and closets, inside all equipment rooms, and areas outside the building exterior envelope, exposed to the outdoors.

1.05 QUALITY ASSURANCE

A. Regulations: Work, materials and equipment shall comply with the latest rules and regulations specified in National Fire Protection Association (NFPA).

B. Discrepancies: The Drawings and Specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's Project Manager in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation at no additional cost to the Owner. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.

C. Contractor Qualifications: An acceptable Contractor for the Work under this Division must have personnel with experience, training and skill to provide a practical working system. The Contractor shall furnish acceptable evidence of having installed not less than three systems of size and type comparable to this Project. All personnel installing equipment under this Division shall possess valid City of Houston and State of Texas licenses for their skill level. Each Journeyman shall supervise no more than two apprentice helpers. Refer also to Owner’s Special Conditions.

1.06 SUBMITTALS

A. Product Data: Provide coordination Drawings with submittals as required by Division 01.

B. Record Documents: In addition to hard copy format, all material submitted as final record products, including approved Shop Drawings and submittals, shall be submitted to the Owner in its original electronic file format on compact disc or DVD. Material may be scanned into electronic file format where necessary.

1.07 DELIVERY, STORAGE AND HANDLING

A. All equipment and materials shall be delivered to the Project Site clean and sealed for protection.

B. Moisture: During construction, protect switchgear, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately upon receiving the products and maintain continually.
C. Damage: Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

D. Finish: Protect factory finish from damage during construction operations until acceptance of the Project. Restore any finishes that become stained or damaged to Owner’s satisfaction.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Equipment and control systems should match, integrate, communicate or cooperate with Owner’s existing systems, such as power monitoring systems, building automation, fire alarm, motor control centers, switchgears, breakers, transformers, and lighting dimming systems.

C. Conditions: Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer’s latest standard design for the type of product specified. Products shall be U.S. made. Owner reserves the right to approve or disapprove foreign-made products.

D. NEC and UL: Products shall conform to requirements of the National Electrical Code. Where Underwriters’ Laboratories have set standards, listed products and issued labels, products used shall be listed and labeled by UL.

E. Space Limitations: Equipment selected shall conform to the building features and shall be coordinated with all components. Do not provide equipment that will not meet arrangement and space limitations. Contractor shall submit room layouts with submitted items shown drawn to scale. Submittals will be rejected without floor plan Drawings showing submitted items.

F. Factory Finish: Equipment shall be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up.

G. Common Source: Equipment specified in Sections 26 22 13, 26 23 00, 26 24 16, 26 24 19, 26 28 17, 26 29 14, 26 43 13 shall be provided by the same manufacturer.

H. Series Ratings: Overcurrent devices shall have fully rated interrupting capacity. Series rating of devices is unacceptable.

2.02 EQUIPMENT AND DEVICE MARKING

A. Externally mark all equipment, devices, conduits for feeders, branch circuits and similar devices using the same circuit designations as indicated on construction drawings and final Record Documents. Conduit marks shall be made at the point of origin and destination of the conduits, using permanent marker.

B. Nameplates shall be black laminated rigid phenolic with white core. Emergency nameplates shall be red laminated phenolic with white cores. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16 inch high engraved white letters. Supply blank nameplates for spare units and spaces.
C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives are not acceptable unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

D. Nameplate Information: The general naming convention shall consist of the following segments:

1. Building name in abbreviated form where equipment is located;
2. Building floor where electrical equipment is located;
3. Electrical system type: NP (normal power), EP (emergency power), LS (life safety branch), CB (critical branch), EB (equipment system branch);
4. System voltage: M (medium voltage), H (277/480V) or L (120/208V);
5. Individual equipment identification: A, B, C, etc.

E. In general, provide the following information for the types of electrical equipment as listed:

1. Switchgears, Switchboards, Distribution Panels and Motor Control Centers: On mains, identify the piece of equipment, the source, and voltage characteristics (i.e., 480/277V 3PH 4W). For each branch circuit protective device, identify the load served.
2. Transformers, Individual Starters, Contactors, Disconnect Switches, Transfer Switches and Similar Equipment: Identify the device designation, voltage characteristics source and load served.
3. Panelboards: Identify panelboard designation, voltage characteristics, and source designation.

F. Panelboards: Prepare a neatly typed circuit directory printed on 80 weight paper. This directory shall be installed behind clear heat-resistant plastic in a metal frame tack welded to the inside of the door for each panelboard. Identify circuits by equipment served and by building room numbers where room numbers exist. Indicate spares and spaces with light, erasable pencil marking. Adhesive mounted directory pocket is not acceptable. Removing and attaching panel schedules from the Drawings is not acceptable.

G. Panelboards, Pull, Junction and Outlet Boxes:

1. With ½ inch high permanent lettering, identify conduits connected to panelboards, pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Neutral conductors shall be identified by wire marker tags in the panelboards, pull, junction and outlet boxes. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags which indicate circuit designation.
2. Emergency circuit junction boxes and their covers shall be painted red. Circuit identification shall be marked on the junction box cover.
3. Fire alarm circuits (only) shall be marked with half red covers and “Fire Alarm” marked on the face.
H. Equipment and raceways over 600 Volts: Provide "WARNING - HIGH VOLTAGE - KEEP OUT" signs on all equipment. With 2 inch-high lettering, mark all exposed raceways containing conductors operating in excess of 600 volts every 100 feet and at each wall or floor penetration with the words "WARNING - HIGH VOLTAGE".

I. Power receptacles, wall switches and dedicated outlets. Identify circuits as per Specification Section 26 27 26.

J. Dedicated outlets: Dedicated is understood to be specific equipment listed by equipment number in the panel schedules or identified on the Drawings. Dedicated also includes computer outlets.

K. Remote Ballasts: For remote ballasts not within five (5) feet of their associated lighting fixture, provide appropriate permanent lettering on both the ballasts and the light fixture to identify which are mated to the other.

2.03 INDUSTRIAL CONTROL PANELS

A. The scope of the work does not intend to cover the Integrated Automation System, neither the design for a functional process control system. It is not intended to apply to the wirings that form an integral part of the equipment, such as motors, controllers, or factory assembled control equipment or listed utilization equipment. It intends to provide the guideline for constructing Industrial Control Panels defined by NFPA 70 Article 409.

B. The electrical requirements pertaining to, but not limited to, branch circuits, luminaires, motor circuits and controllers, air-conditioning and refrigerating equipment, hazardous locations, short-circuit and ground-fault protection, overcurrent/overload protection, industrial machinery, etc. shall be in accordance with the applicable requirements from the specific articles in NFPA 70 Article 409 Table 409.3.

C. Industrial Control Panels shall be built in accordance with the requirements of Division 25 Integrated Automation System, and shall utilize components that are UL listed, UL recognized, or specified by MDACC specifications. Component manufacturers shall have an established network of product distribution for parts replacement. The nearest distribution point shall be within 50 miles of the Project Site.

D. Multi-section industrial control panels shall be bonded together with an equipment grounding conductor or an equivalent equipment grounding bus sized in accordance with NFPA 70 Article 250. Equipment grounding conductors shall be connected to this equipment grounding bus or to equipment grounding termination point provided in a single-section industrial control panel.

E. NFPA 70 Article 110 Table 110.20 shall be used as the basis for selecting industrial control panel enclosures for use in specific locations other than hazardous (classified) locations. Industrial control panel enclosures shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to other switches or overcurrent devices or other equipment, unless the conductors fill less than 40 percent of the cross-sectional area of the wiring space.

F. The phase arrangement on 3-phase horizontal common power and vertical buses shall be A, B, C from front to back, top to bottom, or left to right, as viewed from the front of the industrial control panel.
G. Spacing between live bare metal parts in feeder circuits shall not be less than specified in NFPA 70 Article 430 Table 430.97.

H. Control panel internal wiring shall be installed neatly in panduit system.

PART 3 - EXECUTION

3.01 DEMOLITION

A. Unless otherwise noted, remove all electrical materials and equipment from areas indicated for demolition. Removal of equipment shall not interfere with existing operations.

B. Remove conduit and wire back to panelboards or to nearest junction box that is not being removed and needs to remain in service. Wire shall be removed back to point of origin. Turn off circuit breakers or switches serving abandoned circuits and tag breaker or switch and label in panel schedule as “Spare”.

C. Materials and equipment to be removed, except items specifically noted to be relocated or delivered to the Owner, become property of the Contractor and shall be immediately removed from the Project Site. If the Owner identifies other items during construction, those items become Owner property and will be turned over to the Owner.

D. Electrical services and controls to items being removed shall be disconnected and removed from the Project Site.

E. All fluorescent lighting fixtures being removed from the Project Site that will not be turned over to the Owner shall have any PCB-containing ballasts removed from the fixtures for environmental disposal. Ballasts shall remain intact with wire leads at least twelve (12) inches long.

F. Contractor shall ensure that light switches within the Work area remain operational. Where temporary 120 volt light strings are installed, a switch shall be provided for the light strings near the Project entry door.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Installation shall be in accordance with manufacturer’s published recommendations.

C. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.

D. Cooperation with Other Trades: Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

E. Workmanship: Work shall be performed by competent workers skilled in their trade. This installation must be complete.
F. Housekeeping Pads: Unless otherwise noted. Install 3 1/2 inch thick concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond equipment. Trowel pads smooth and chamfer edges to a 1 inch bevel. Secure equipment to pads as recommended by the manufacturer.

G. Setting of Equipment: Equipment must be leveled and set plumb. Sheet metal enclosures mounted against a wall must be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers or by 3 inches of air for freestanding units. Use corrosion resistant bolts, nuts and washers to anchor equipment. Provide Drawings and layout Work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases in sufficient time to be coordinated with Work under other divisions.

H. Sealing of Equipment: Seal openings into equipment to prevent entrance of animals, birds and insects.

I. Motors: Electrical Work includes the electrical connection of all motors, except those that are wired as a part of equipment.

J. Concealed Work: Conceal all electrical Work in walls, floors, chases, under floors, underground, and above ceilings except:

1. Where shown or specified to be exposed. Exposed is open to view.
2. Where exposure is necessary to the proper function.
3. Where size of materials and equipment preclude concealment.

K. Application: Unless otherwise indicated, power will be utilized as follows:

1. 480 volts, three phase: Motors ¾ horsepower and larger and electric heating equipment.
2. 120 volts, single phase: Motors ½ horsepower and smaller.
3. 120 volts, single phase: Incandescent lighting and fluorescent task lighting.
4. 277 volts, single phase: Fluorescent and high-intensity-discharge lighting and electric heating equipment.
5. 120 volts, single phase: Convenience outlets.
6. 208 volts, single and three phase: Power outlets.

L. Transformers: Use transformers to change the service to the required utilization voltages.

M. Provide final electrical connections to equipment furnished under other divisions and by the Owner. Furnish detailed Shop Drawings of equipment indicating the exact number and location of rough-in points. Such final Shop Drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the Work required.
1. Roughing-in: When roughing-in electrical branch circuits to various items of equipment, terminate at proper points as indicated on detailed equipment Shop Drawings or as directed by Owner. Do not rely on Drawings accompanying these Specifications for rough-in locations, only for general routing of circuiting.

2. Final Connections: Laboratory casework, medical equipment, and food service equipment will include service fittings such as switches, duplex receptacles, lighting fixtures, etc., on the casework or equipment. Provide branch circuit connections to meet service fitting requirements.

N. Refer to Divisions 07 and 09 for sealing and firestopping requirements where raceways penetrate smoke, fire, and sound rated walls.

O. All unused openings such as but not limited to, knockouts on panels and boxes, surface wireway openings, busway openings, circuit breaker empty slots shall be covered with approved cover plates.

P. Temporary power equipment and distribution for construction shall not occupy building spaces or block pathways that are designated for permanent installation of other trades according to design drawings.

3.03 TESTING

A. Test Conditions:

1. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's representative(s). Furnish all instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Contract Documents. Special tests on certain items are specified hereinafter.

2. Testing shall be performed by an independent testing company that is Owner approved, and National Electrical Testing Association (NETA) certified. Submit copies of test reports.

3. Prior to testing, Contractor shall submit to Owner for approval, installation verification Prefunctional Checklists and Functional Performance Test procedures. These shall be used for documentation as part of the commissioning process.

4. All instruments required for conducting the tests shall be NIST (National Institute for Standard and Technology) certified or traceable, and calibrated at the time of testing.

B. Test Dates: Schedule final acceptance sufficiently in advance of the Contract date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the Contract. Provide written notification to Owner at least fourteen (14) calendar days in advance of Functional Performance Test dates.

C. Retests: If retesting is required due to initial failure, conduct retests of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant delay as a result of such necessary retests does not relieve the Contractor of Contractor's responsibility under this Contract.
D. Circuit Verification: All 120-volt single-phase circuits shall be verified to match the Drawings and panel schedules by "ringing out" each circuit in the presence of the Owner’s representative(s).

E. Refer to Commissioning Specification Sections for additional start-up, prefunctional and operational checkout, and for functional performance test procedures.

END OF SECTION 26 01 00
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section specifies the requirements for 600-volt cable, wire and connectors. It consists of but is not limited to power distribution circuitry, control system circuitry, lighting circuitry, appliance, equipment and motor-branch circuitry and outdoor power and lighting circuitry.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. NEMA WC 3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

2. NEMA WC 5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

3. Where application of National Electrical Code, appears to be in conflict with the requirements of this section, the Owner shall be asked for an interpretation.

1.04 SUBMITTALS

A. Product Data:

1. Submit manufacturer’s data on cable and wire connectors.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from the Project Site.

B. In their factory-furnished coverings, store cable, wire and connectors in a clean, dry indoor space which provides protection against the weather.
PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper stranded with insulation as noted below. Minimum size for control circuits shall be #14 copper stranded.

2.02 MANUFACTURERS

A. Interstate Wire Company.
B. American Insulated.
C. Okonite.
D. Southwire.
E. Encore Wire.

2.03 BUILDING WIRE

A. NEMA WC 70 – Nonshielded 0-2kV Cables
B. Feeders and Branch Circuits all sizes: 98 percent conductivity copper, stranded conductor, 600-volt insulation, THHN/THWN. Use XHHW insulation for all isolated power circuits.
C. Control Circuits: 98 percent conductivity copper, stranded conductor, 600 volt insulation, THHN, THWN.
D. Color Coding:
   1. Branch Circuit and Feeders:
      
      | Phase A | 280Y/120 Volts | 480Y/277 Volts | 120/240 Volts |
      |---------|---------------|---------------|---------------|
      | Phase A | Black         | Yellow        | Black         |
      | Phase B | Red           | Brown         | Red           |
      | Phase C | Blue          | Orange        | ----          |
      | Neutral | White with tracer | Gray with tracer | White with tracer |
      | Ground  | Green         | Green         | Green         |

   2. The above colors shall be used unless requirements of code require different colors. When connecting to existing circuits, existing color coding shall be utilized. The neutral tracer color shall match the phase conductor color that it is associated with. Lighting circuits with shared grounding conductor are not required to have tracer colors on the wire.

   3. Secondary conductors from isolation transformers shall be: Conductor 1-orange and conductor 2-brown.
4. Conductors No. 8 AWG and larger shall be identified by colored plastic tape that matches the circuit phase color at all visible points when colored insulation is unavailable. Colored tape shall be located and of such a quantity to readily indicate the conductor phase.

E. Type AC and MC cable assemblies shall be permitted only with proper cable management via cable trays and with Owner’s prior written approval.

2.04 REMOTE CONTROL AND SIGNAL CABLE

A. Control Cable for Class 1 Remote Control and Signal Circuits: 98 percent conductivity copper conductor, 600-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded and covered with a PVC jacket.

B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: 98 percent conductivity copper conductor, 300-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 - EXECUTION

3.01 PREPARATION

A. Installer must examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor and Owner in writing of conditions detrimental to the proper and timely completion of the work.

B. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. General wiring methods:

   1. Install electrical cable, wire and connectors as indicated. All installations, temporary or permanent, shall be in accordance with the manufacturer’s written instructions, the applicable requirements of NEC, and as required ensuring that products serve the intended functions.

   2. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

   3. Cables shall be selected on the basis of their purpose and UL listing. Generally, use Types THWN, XHHW and THNN in building interiors and other dry locations. Outdoors and in underground in raceways, use Type THWN or THHN. Conductors subject to abrasion, such as in lighting poles, shall be Type THWN or THHN.
4. No conductor smaller than No. 12 wire shall be used for branch circuit wiring. In the case of "homeruns" over 50 feet in length (100 feet for 277 volt), no conductor smaller than a No. 10 wire shall be used. The tap conductor from the J-box in the ceiling to the receptacle may be No. 12. Each 120-volt phase conductor shall have a neutral conductor of the same size. The sizing of all wire except remote control wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions.

a. 480 Volt Branch Circuits: The voltage drop in the case of 277/480 volt circuits shall not exceed 1.0 percent at maximum load and 70.0 percent power factor.

b. 120/208 Volt Branch Circuits: The voltage drop in the case of 120/208 volt circuits shall not exceed 2.0 percent at maximum load and 70.0 percent power factor.

5. Remote control wires shall be no smaller than No.14 AWG stranded copper conductors and shielded with drain. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code requires the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. This voltage drop shall be based on the full load, 70 percent power factor, the total impedance drop with 60-hertz alternating current and with the reactance drop in the respective metal conduits duly considered. The Contractor may, if Contractor deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner’s duly authorized representative.

D. Wiring Installation Raceways:

1. Wire and cable shall be pulled into clean dry conduit.

2. Pull conductors together where more than one is being installed in a raceway.

3. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation. No pulling compound shall be used when pulling isolated power circuits utilizing XHHW insulation.

4. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed. Wires with damaged insulation shall be replaced at no cost to the Owner.

5. Place an equal number of conductors for each phase of a circuit in same raceway.

6. No more than three phase conductors shall be installed in same conduit. Line conductors shall not share the same conduit with load conductors.

E. Wiring Connections and Terminations:

1. Splicing cable or wire is not allowed unless it is explicitly designed by the Engineer, or for equipment connection per equipment manufacturer’s recommendation. Where splices are to be implemented, approval of the Owner must be obtained before installation is made. Provide electrical boxes where splices are made.

2. Thoroughly clean wires before installing lugs and connectors.
3. Terminate indoor spare conductors with electrical tape in a box.

4. Conductors installed outdoors or in garages, whether in use or spare, shall be installed in conduits and terminated in boxes that are rated for outdoor use with listed connectors that are rated for watertight/rain tight applications. The use of indoor wire nuts with electrical tape is prohibited for installations outdoors or in garages.

F. Field Quality Control:

1. Torque test conductor connections and terminations to manufacturer’s recommended values.

2. Perform continuity test on all conductors. Verify proper phasing connections and phase rotation, where applicable.

3. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than series wiring of fixtures.

4. Conductors may be run parallel on sizes 1/0 to 500 kcmil inclusive provided all parallel conductors are the same size manufacturer, length and type of insulation. Except as otherwise shown on Drawings, no more than three (3) conductors may be run in parallel, and they shall be so arranged and terminated as to ensure equal division of the total current between all conductors involved. Where parallel connection is contemplated, approval of the Owner must be obtained before installation is made.

3.03 TESTING

A. Before final acceptance, the Contractor shall make voltage, insulation and load tests, necessary to demonstrate to the Owner the satisfactory installation and proper performance of all feeder circuits.

B. Test feeder conductors to determine the conductors are clear of faults, high resistance connections and megger test same at 600 volts DC. Test results below 30 mega ohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductors.

END OF SECTION 26 05 19
SECTION 26 05 26 – GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Ground the electrical service system neutral at service entrance equipment to grounding counterpoise loop. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Provide a completely grounded system in accordance with Article 250 of the NEC.

B. Metal water piping system(s) installed in or attached to a building or structure shall be bonded to the service equipment enclosure, the grounded conductor at the service. Where installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to the service equipment enclosure, the grounded conductor at the service. The bonding jumper(s) shall be sized in accordance with Article 250 of the NEC.

C. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformers, UPS systems, power conditioners, inverters, or other power supplies that are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.

D. Concrete reinforcing bars shall be permitted for grounding. Connect the structural metal frame to the reinforcing bars of concrete-encased electrode. Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system where the steel reinforcing bars or rods are not accessible for use without disturbing the concrete.

E. Provide communications system-grounding conductor at point of service entrance and connect to Telecommunications Main Grounding Busbar (TMGB). Bond together the communications system grounding.

F. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, metal cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metallic plumbing systems.
G. The major components of the Telecommunications Grounding and Bonding infrastructure are as follows:

1. The Telecommunications Main Grounding Busbar (TMGB).
2. The Telecommunications Grounding Busbar (TGB).
3. The Telecommunications Bonding Backbone (TBB).
4. The Telecommunications Bonding Conductor (TBC).
5. Grounding Equalizer (GE).

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All design, materials, installation and testing pertaining to grounding and bonding system shall comply with the latest edition of applicable requirements and standards addressed within the following references:

2. UL 467 - Grounding and Bonding Equipment.
5. NFPA 70 - National Electrical Code (NEC).
7. LPI (Lightning Protection Institute) 175- Standard of Practice for the Design - Installation - Inspection of Lightning Protection Systems.
8. UL 96 - Lightning Protection Components.
13. UL 497 - Protectors for Paired-Conductor Communications Circuits.
14. UL 497A - Secondary Protectors for Communications Circuits.
15. UL 497B - Protectors for Data Communications and Fire-Alarm Circuits.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MATERIALS AND EQUIPMENT

A. Grounding system components shall be as required to comply with the design and construction of the system indicated. Components shall be as indicated in manufacturer's submittal data.

B. Ground Conductors:

1. Materials:
   a. Provide 600-volt insulated conductors having a green-colored insulation for grounding electrode and equipment grounding conductors. Use stranded conductors.
   b. Conduit grounding conductors shall be insulated copper conductor, green in color to size #6 AWG. Insulated conductors larger than #6 AWG shall be same as phase conductors but identified with green tape at each accessible opening or location in raceway.
   c. Provide bare conductors for bonding jumpers.
   d. Cable tray grounding conductors shall be a minimum of 1/0 bare copper conductors.

C. Connections:

1. Materials:
   a. Unless otherwise noted, for below-grade connections provide exothermic welded type.
   b. For above-grade connections provide mechanical bolted-type connections utilizing high conductive copper alloy or bronze lugs or clamps.
   c. Where required, provide plated connectors that will not cause electrolytic action between the conductor and the connector.

D. Grounding clips shall be O-Z Gedney, Steel City (Thomas & Betts) Type G.

E. Grounding Electrodes:

1. Grounding electrodes shall not be smaller than ¾-inch diameter, with minimum length ten (10) feet.
2. Grounding electrodes shall be copper-clad steel for corrosion protection.

F. Grounding Busbar:
   1. Where a field-provided ground bus or ground bar is required, use round-edge copper bar with 98 percent International Annealed Copper Standard (IACS) conductivity.
   2. Size the bus for not less than 25 percent of the cross-sectional areas of the related feeder. A minimum size of ¼-inch thick by 2-inch depth by 6-inch length (minimum) is required.
      a. The ground bar shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used.
      b. The ground bar shall be tin-plated for reduced contact resistance.
      c. The ground bar shall be insulated from its support. A minimum of 2 inches separation is required. Mount the grounding busbars on insulated standoffs to ensure isolation from ground potential or stray potentials.

PART 3 - EXECUTION

3.01 INSTALLATION
   A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
   B. All installations shall be in accordance with manufacturer’s published recommendations.
   C. Install ground system as indicated, in accordance with the applicable requirements of the NEC. Coordinate installation of grounding and lightning protection system components with structural and civil Drawings and placement of building structure.
   D. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes.
   E. Size: When grounding and bonding conductors are not sized on Drawings, size the grounding conductors in accordance with NEC. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC.
   F. Connect grounding electrode conductors to metal water pipe using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
   G. Exothermic welding shall be utilized for ground connections where they are concealed, or inaccessible.
   H. Strap grounding clamps shall not be used. A connection requiring bolting shall be made up with Monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.
   I. Supplementary Grounding Electrode: Use effectively grounded metal frame of the building.
J. Provide grounding and bonding at Utility Company’s metering equipment in accordance with Utility Company’s requirements.

K. Conduit and raceway systems shall not be considered a ground path. Provide an internal insulated grounding conductor in all conduits and raceways. Size grounding conductors in accordance with the NEC. Where grounding conductor sizes are shown in excess of code requirements, provide conductor sizes as indicated.

L. In feeder and branch circuits, provide a separate, green, insulated equipment-grounding conductor with the circuit conductors. Terminate each end of the grounding conductor on a grounding lug, bus, or bushing.

M. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate, or by the use of an approved grounding yoke type receptacle.

N. Install an insulated grounding conductor internally to all flexible metal conduits. Provide suitable grounding bushing at each end of liquid tight flexible metal conduit at transformers only. The grounding bushing shall contain a bonding jumper and shall be terminated at the equipment ground bus. The grounding conductor shall terminate at the equipment ground bus.

O. Where accessible, conductor connections shall be made by means of solder-less connectors such as serrated bolted clamps or split bolt and nut type connectors.

P. Measure ground resistance from neutral connection at service entrance to ground reference point using suitable grounding testing equipment. Resistance shall not exceed 5 OHMS.

3.02 FIELD QUALITY CONTROL

A. System Neutral: Where a system neutral is used, bond the system neutral to the grounding electrode system in accordance with NEC. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.

B. Separately Derived Systems: Ground neutrals of separately derived systems such as generators, transformers, etc., in accordance with NEC.

C. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device.

D. Size: Size the system grounding electrode conductors to comply with NEC.

E. Connect grounding electrode conductor pigtails at each grounding electrode to building structural steel, as indicated.

F. Connect main grounding electrode conductor pigtails to power system neutral, as indicated on Drawings.

G. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

3.03 EQUIPMENT GROUND

A. Manholes:
1. Provide a No. 1/0 AWG bare stranded copper ground bus in all manholes. Mount bus 12 inches above floor using one-hole pipe straps three (3) feet on center.

2. Connect bus to ground rod with a No. 1/0 AWG conductor. Bond all metallic components and electrical grounding conductors to the bus using lugs or clamps.

B. Transformer Rooms, Electric Rooms, Switchgear Rooms, and Generator Rooms:

1. Provide 4/0 copper ground wire loop in each room for bonding and grounding.

2. Mount ground loop 12 inches below suspended ceiling or structural ceiling and around the perimeter of room.

3. Connect ground loop to vertical ground bus (cable) riser grounding plate. Bond all non-current carrying metallic parts of electrical equipment in the room to the ground loop by bonding jumper(s) sized in accordance with Article 250 of the NEC.

C. Raceway Systems and Equipment Enclosures:

1. Ground cabinets, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, transformer enclosures, other electrical equipment and metallic enclosures. Ground equipment and enclosures to the continuous-grounded metallic raceway system in addition to any other specific grounding shown.

2. Provide bonding jumpers and ground wire throughout to ensure electrical continuity of the grounding system.

3. Provide grounding-type insulated bushings for metal conduits 1-1/2 inches and larger terminating in equipment enclosures containing a ground bus and connect the bushing to the ground bus. (NOTE: This applies to conduits containing phase conductors only and not control circuits).

4. Provide a green insulated equipment-grounding conductor for each feeder and branch circuit.

D. Taps and Connections: Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends.

3.04 TELECOMMUNICATIONS GROUNDING AND BONDING INFRASTRUCTURE

A. Isolated (Single Point) Ground:

1. Purpose:

   a. An isolated single point grounding system is employed for installations utilizing sensitive electronic, data processing or communications equipment.

   b. This single ground bus is not connected in electrical loops, but in a radial configuration between the various electronic equipment locations.

   c. The single ground bus is then connected to the building electrical service equipment ground. This grounding arrangement thus provides only a single path to ground for any circulating ground currents, which will minimize electromagnetic interference with sensitive electronic equipment.
2. Equipment Requiring Isolated Grounding: Equipment typically grounded to the isolated single point grounding system includes communications and coaxial cable shields, telephone termination block earth grounds, radio transmitter chassis grounds, and electronic equipment signal grounds which are isolated from the equipment chassis.

3. Grounding Busbars:
   a. Install a local isolated ground busbar in each room or area where indicated on the Drawings. Ground all sensitive electronic equipment in the room or area to the local isolated ground bus.
   b. Install a master isolated ground busbar for the entire building or plant structure. Connect radial isolated ground leads from each local isolated ground bus to the master isolated ground bus.

4. Grounding Conductors:
   a. Conductors from individual equipment and cable shields shall be a minimum No. 6 AWG, type THW stranded copper with green insulation. The conductor from each local isolated ground bus to the master isolated ground bus shall be a minimum of No. 2/0 AWG, type THW stranded copper with green insulation. The conductor from the master isolated ground bus to the facility ground rod array shall be a minimum of No. 2/0 AWG, type THW stranded copper with green insulation. Grounding cable with aluminum conductors is not acceptable.
   b. Conductors shall be routed to provide the minimum possible number of cable bends. The radius of any cable bend shall be not less than 8 inches, and the included angle of any bend shall be a minimum of 90 degrees.

5. Grounding Connectors:
   a. Connections from individual equipment and cable shields shall use crimp-type connectors of copper or tinned copper construction. Individual equipment connections to local isolated ground buses shall use copper alloy or bronze machine bolts and lock washers.
   b. No. 2/0 cable connections from local isolated ground buses to the master ground bus shall utilize an exothermic weld or brazing process. No. 2/0 cable connections from the master ground bus to the facility ground rod array shall utilize an exothermic weld or brazing process.
   c. Paint-piercing grounding washers shall be used.
   d. Connectors utilizing aluminum or steel alloys are not acceptable.

6. Connections to Isolated Grounding Systems: Use insulated equipment grounding conductor and connect only to service grounding electrode. Where isolated grounding system is associated with a separately derived system, bond isolated grounding conductor to system neutral at source of separately derived system in accordance with NEC.

B. General:
1. All bonding conductors and connectors shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL).

2. All bonding conductors shall be green-insulated copper conductor. The minimum bonding conductor size shall be a No. 6 AWG. Leave a minimum of 10 feet slack conductor at termination board.

3. Route ground conductors to provide the shortest, most direct path from point to point. Telecommunications ground must be bonded to the lightning protection system grounding and may need additional bonding depending on: spacing, building dimensions, and construction.

4. Bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, the conductors shall be bonded to each end of the conduit with a conductor sized as a No. 6 AWG, minimum (this makes the conduit a parallel path with the cable).

5. A continuous ground path shall be provided in all telecommunications raceways. Grounded cable trays shall be considered continuous ground path.

6. At each TR all equipment and raceways shall be bonded to the TGB.

7. Any grounding or bonding conductor that is run through a metallic conduit shall be bonded to the conduit.

8. Gas pipes shall not be used as a grounding electrode.

9. Provide dedicated Telecommunications Bonding Backbone (TBB) to interconnect the TRs and related equipment.

C. Telecommunications Entrance Facility (TEF) Telecommunications Main Grounding Busbar (TMGB):

1. The Telecommunications Main Grounding Busbar (TMGB) serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB also serves as the central attachment point for telecommunications bonding backbones (TBB) and equipment, and is located such that it is accessible to telecommunications personnel.

2. The TEF is the desirable location for the TMGB. This TMGB may serve as the TGB for collocated equipment in the TEF. The TMGB shall be bonded to electrical service equipment ground.

3. Where an electrical panelboard is located in the same room or space as the TMGB, the ground or enclosure of that electrical panelboard shall be bonded to the TMGB. Locate the TMGB as close to the electrical panelboard as practical to maintain clearances required by applicable electrical codes.

4. Locate the TMGB near the TBB cabling and associated terminations. The connections of the bonding conductors for telecommunications, and the TBBs to the TMGB shall utilize listed two-hole compression lugs.
5. Telecommunications primary protector grounding conductor shall be bonded to the TMGB. A minimum of 1 foot separation shall be maintained between this insulated conductor and any DC power cables, switchboard cables, or high frequency cables, even when placed in metal raceway.

6. The TMGB shall have minimum dimensions of ¼-inch thick x 4-inch wide and 12-inch in length with 18 attachment points (two rows of 9 each). The length may need to be adjusted longer to meet the application requirements with consideration of future growth. The busbar shall be UL Listed as grounding and bonding equipment.

7. The TMGB shall be a predrilled solid copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 15 two-hole grounding lugs with 5/8” hole centers and 3 two-hole lugs with 1” hole centers. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” standoff from the wall.

8. All metallic raceways for telecommunications cabling located within Equipment Room (ER) shall be bonded to the TMGB. However, for metallic raceways containing grounding conductors where the raceway is bonded to the ground conductor, no additional bonding to the TMGB is required.

9. In buildings where the backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TMGB where the cables are terminated or where pairs are broken out.

10. In a metal frame (structural steel) building, where the steel framework is readily accessible within or external to the ER; each TMGB shall be bonded to the vertical steel metal frame.

D. Telecommunications Room (TR) Telecommunications Grounding Busbar (TGB):

1. The TGB is the grounding connection point for telecommunications systems and equipment in the location served by that TR or ER. Each TR and ER shall contain a TGB. Multiple TGBs may be installed within the same TR or ER to aid in minimizing bonding conductor lengths and terminating space. In all cases, multiple TGBs within the same ER shall be bonded together with a conductor the same size as the TBB.

2. The TGB shall be located near the TBB cabling and associated terminations.

3. The bonding conductor between a TBB and TGB shall be continuous and routed in the shortest possible straight-line path. The bonding conductor shall be the same size as the TBB.

4. The TGB shall have minimum dimensions of ¼-inch thick x 2-inch wide and 10-inch in length with 7 attachment points (one row). The length may need to be adjusted longer to meet the application requirements with consideration of future growth. The busbar shall be UL Listed as grounding and bonding equipment.
5. The TGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 4 two-hole grounding lugs with 5/8” hole centers and 3 two-hole lugs with 1” hole centers. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” standoff from the wall.

6. All metallic raceways for telecommunications cabling located within TR shall be bonded to the TGB. However for metallic raceways containing grounding conductors where the raceway is bonded to the ground conductor, no additional bonding to the TGB is required.

7. In buildings where the backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TGB where the cables are terminated or where pairs are broken out.

8. In a metal frame (structural steel) building, where the steel framework is readily accessible within or external to the TR; each TGB shall be bonded to the vertical steel metal frame. When practicable because of shorter distances and other considerations, and where horizontal steel members are permanently electrically bonded to vertical column members, TGBs may be bonded to these horizontal members in lieu of the vertical column members.

E. Telecommunications Bonding Backbone (TBB):

1. A TBB is a conductor that interconnects all TGBs with the TMGB. A TBB’s basic function is to reduce or equalize potential differences between telecommunications systems bonded to it. A TBB is not intended to serve as the only conductor providing a ground fault current return path.

2. A TBB shall be designed with consideration given to the type of building construction, building size, the telecommunications requirements, and the configuration of the telecommunications pathways and spaces. Specifically, the design of a TBB shall:
   a. Be consistent with the design of the telecommunications backbone cabling system.
   b. Permit multiple TBBs as dictated by the building size.
   c. Address routing to minimize the lengths of the TBB.

3. Whenever two or more TBBs are used within a multistory building, the TBBs are to be bonded together with a Grounding Equalizer (GE) at the top floor and at every third floor in between. The GE is sized the same as the TBB.

4. TBB conductors shall be installed without splices. Where splices are required, they shall be kept to the minimum quantity necessary, shall be accessible and located in telecommunications spaces. Joined segments of a TBB shall be connected using irreversible compression-type connectors, exothermic welding, or accepted substitution. All joints shall be adequately supported and protected from damage.

F. Telecommunications Bonding Conductors (TBC):

1. Provide conductors used to bond components to the TMGB and the TGBs as follows:
a. The minimum size for this conductor shall be 6 AWG green-insulated, stranded copper cable.

b. Avoid unnecessary connections or splices in TBCs. When necessary, use an approved connection and position it in an accessible location.

c. Typical connections are made by using: bolts or crimps (connectors, clamps, or lugs). Where possible, use irreversible compression-type connections and two-hole lugs. Always use listed hardware that has been laboratory tested.

2. Bonding conductor sizing. The following table applies to Telecommunications Bonding Backbone (TBB), Grounding Equalizer (GE) and Telecommunications Bonding Conductor (TBC).

<table>
<thead>
<tr>
<th>Bonding Conductor Length (ft)</th>
<th>Bonding Conductor Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 13</td>
<td>6</td>
</tr>
<tr>
<td>14 - 20</td>
<td>4</td>
</tr>
<tr>
<td>21 – 26</td>
<td>3</td>
</tr>
<tr>
<td>27 – 33</td>
<td>2</td>
</tr>
<tr>
<td>34 – 41</td>
<td>1</td>
</tr>
<tr>
<td>42 – 52</td>
<td>1/0</td>
</tr>
<tr>
<td>53 – 66</td>
<td>2/0</td>
</tr>
<tr>
<td>Greater than 66</td>
<td>3/0</td>
</tr>
</tbody>
</table>

G. Testing Telecommunications Grounding and Bonding Infrastructure

1. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

2. Measure ground resistance from longest grounding path to MTGB or TGB in TR or ER. Resistance shall not exceed 0.1 ohms.

END OF SECTION 26 05 26
SECTION 26 05 33 – RACEWAYS, CABLE TRAYS, AND BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section specifies the requirements for raceways, conduits and boxes.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
3. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
4. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
5. ANSI/UL 1 - Flexible Metal Conduit.
6. ANSI/UL 5 - Surface Metal Raceways and Fittings.
7. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
8. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
9. ANSI/UL 797 - Electrical Metallic Tubing.
10. ANSI/UL 870 - Wireways, Auxiliary Gutters and Associated Fittings.
11. ANSI/UL 884 - Underfloor Raceways and Fittings.
12. NEMA VE I - Metallic Cable Tray Systems.
13. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
15. UL514B - Standard for Safety, Fittings for Conduit and Outlet Boxes
16. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.05 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's product data for raceways, conduits, outlet boxes, and wireways.

B. Shop Drawings:
   1. Submit Shop Drawings of the complete metal surface raceway system.
   2. Shop Drawings shall include sizes and lengths of raceways as verified with laboratory furniture Shop Drawings, inside corners, outside corners, end caps, raceway cover spacing, grounding, branch circuiting and wiring including locations of service entrances, receptacle types and manufacturers, receptacle spacing, and receptacle labeling with proper voltage, phase, circuit and panelboard designations as indicated on the Drawings.
   3. Submit firestopping installation Shop Drawings to cover the following scope, but not limited to. The Contractor shall obtain Owner's approval prior to installation.
      a. Product data sheet from a manufacturer that is specified by Section 07 84 13 Penetration Firestopping.
      b. Dimensioned installation Shop Drawing detail(s) with UL listed firestopping assembly number that is associated to the same material manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 WIREWAYS AND TERMINAL BOXES

A. Wireways and terminal boxes shall be of steel construction, oil-tight with knockouts.

B. Size shall be minimum 4 x 4 inches or as indicated on the Drawings.

C. Cover shall be hinged.

D. Fittings shall be so constructed to continue the "lay in" feature throughout the entire installation.
E. Provide all sheet metal parts with a rust-inhibiting phosphatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

F. Inside Terminal Boxes: Provide 25-ampere, 300-volt industrial rated terminal blocks with marking strip. Mark strip with black ink identifying circuit connection. Provide nameplate on exterior of each terminal box indicating panelboard served.

2.03 CONDUIT AND FITTINGS

A. Manufacturers:

1. Conduit and Electrical Metallic Tubing: Allied Tube & Conduit or equal.

2. Fittings: Appleton Electric, Midwest Electric Products or O-Z/Gedney.

3. Expansion Fittings: O-Z/Gedney Type DX, Crouse-Hinds Type XC, or equal by Midwest Electric Products or Appleton Electric.

4. Flexible Metal Conduit and Fittings: Anaconda Sealtite, Type UA.

B. Application:

1. Conduit and fittings for all electrical systems on this Project shall include the following:
   a. Service entrance.
   b. Electrical power and lighting feeders.
   c. Electrical power and lighting circuits.
   d. Building automation systems (BAS).
   e. Fire alarm and signaling systems.
   f. CCTV rough-in system.
   g. Telecommunications rough-in system (minimum 6-inch bending radius for telecommunications conduits).
   h. Nurse call system.
   i. Security systems.
   j. Other electrical systems, as identified on the Drawings.

C. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, and other components and accessories as needed to form a complete system of the type indicated.

D. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by NEC Article 250-28. Grounding bushings shall have insulated throats.

E. Rigid metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type.
F. Electrical metallic tubing shall be galvanized. Fittings shall be all steel set screw deep socket UL marked and approved for the application. Compression fittings uses shall be in, not limited to, wet damp and environmental areas type.

G. Flexible metal conduit and fittings shall be zinc-coated steel.

H. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC).

I. Crimp type fittings are not acceptable.

J. Raceways such as electrical nonmetallic tubing (ENT) and liquid-tight flexible nonmetallic conduit (LFNC) are not acceptable for use on any Project.

2.04 WALL AND CEILING OUTLET BOXES

A. Manufacturers: Appleton Electric, RACO-Hubbell, Thomas & Betts - Steel City, Cooper Crouse-Hinds.

B. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Minimum switchbox depth shall be 2 inches. Outlet boxes for electrical power shall be 2-1/8 inches deep. Outlet boxes for communication (voice and data) shall be minimum 3-1/2 inches deep.

1. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes.

2. Accessories shall be compatible with outlet boxes being used and shall meet requirements of individual situations.

C. Corrosion-resistant cast-metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with threaded conduit ends, cast metal faceplate with spring-hinged waterproof cap and corrosion-proof fasteners.

D. Outlet boxes in poured concrete shall be plenum type without holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

2.05 FLOOR BOXES

A. Manufacturers: RACO-Hubbell, Wiremold, FSR.

B. Boxes shall be NEMA OS 1, fully adjustable, minimum 1-1/2 inch depth for electrical power only; 4-1/2 inch minimum depth for communication.

C. Boxes shall conform to regulatory requirements for concrete-tight floor boxes.

D. Service fittings shall be as specified on Drawings.

E. Poke-thru box fittings shall maintain a minimum two-hour fire rating.
2.06 PULL AND JUNCTION BOXES

A. Boxes shall be galvanized sheet metal with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.

B. Boxes larger than 12 inches in any dimension shall be panelboard code gauge galvanized steel with hinged cover.

C. Boxes shall be sized in accordance with NEC.

2.07 CABLE TRAY AND FITTINGS

A. Manufacturers: Square D, B-Line, Chalfant.

B. Material: Hot rolled, carbon steel strip, hot-dipped galvanized after fabrication with either hot-dipped galvanized or cadmium-plated fasteners.

C. Dimensions: (exceptions as noted on Drawings):
   1. Depth: 6 inches or as indicated otherwise.
   2. Width: 24 inches or as indicated otherwise.
   3. Radius: 36 inches or as indicated otherwise.

D. Type: Ladder.

E. Covers: Where indicated on the Drawings, provide trough-type cable tray with galvanized bolt-on covers.

2.08 SURFACE METAL RACEWAYS

A. Manufacturers: The Wiremold Company 3000 or 4000 Single-Channel System. Systems of other manufacturers may be considered equal if they meet all performance standards as specified herein. Wiremold 4000 shall be used for communication applications.

B. Raceway base and cover sections shall be UL Listed, manufactured of cold rolled steel, and finished in gray enamel.
   1. Raceway shall be a two-piece design with a metal base and a snap-on metal cover.
   2. Surface metal raceways installed in controlled environmental and cold rooms. Install gasket flip type weather resistant cover plates in lieu of stainless cover plates for receptacles.

C. Furnish with all entrance fittings, elbows, end caps, covers, and device brackets and plates as indicated on the Drawings for a complete system.
   1. Fittings shall be finished in enamel to match the raceway.
   2. Fittings shall be supplied with a base where applicable to eliminate mitering.

D. Provide couplings, elbows, connectors, boxes, extension rings and outlet covers specifically designed for use with surface raceway system.
E. Provide factory fittings for vertical raceway riser connection to horizontal raceway runs. Such directional change fittings must accommodate required radius flex for Category 6a communication cable under both load and no load conditions.

F. All internal exposed surfaces within the raceway, including joints and covers shall be free of nicks, cuts, sharp edges, and other imperfections.

G. Grommets shall be used to accommodate building automation system cabling to critical equipment or as noted on Drawings.

H. Multiple raceways shall be provided for normal power, emergency power, and communication / critical alarm as noted on the Drawings.
   1. Raceway lengths shall be as shown on the Drawings.

I. Multi-Outlet Assembly Devices:
   1. Provide hospital grade, duplex receptacles mounted 12 inches on center unless noted otherwise. Unless otherwise noted, alternate circuits between receptacles.
   2. In laboratory applications, normal power receptacles shall have alternating colors for different circuits:
      a. Phase A = gray
      b. Phase B = brown
      c. Phase C = white
   3. Exceptions to the color would be single circuit raceway, which shall be white.
   4. Receptacles serving emergency circuits shall be red in color.
   5. Isolated ground receptacles shall be orange in color.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL
A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Concrete metal hit anchor and fastener is an unacceptable fastening system for concrete, brick and block.

D. Where raceways or cable trays penetrate fire-rated floors or roofs, sleeve and seal opening around raceways and cable trays with UL listed firestop assemblies equal to fire rating of floors or roofs. Seal penetrations through all floors or roofs to provide and maintain a watertight installation. Conduit sleeves, where required, shall be two (2) trade sizes larger for proper sealing and extend 2 inches above the surface. Refer to Section 07 84 13 Penetration Firestopping and Section 09 29 00 Gypsum Drywall for sealing and firestopping requirements where raceways penetrate smoke, fire, and sound rated walls. The installation shall be in compliance with UL listed firestopping assembly.
E. Support all conduits and J-boxes above ceilings from the building structure. All J-boxes being installed above suspended ceilings must have a minimum of 12-inch working clearance between the bottom of J-boxes and the top of the ceiling grid except where approved by the Owner in writing prior to installation.

F. No raceways, metallic or non-metallic, flexible or rigid, shall be installed in any floor slab elevated above slab on grade. The only exception may be for the lighting grid in the parking deck areas of a parking garage.

G. Bushings and throats shall be installed for fittings, raceways, boxes or other enclosures prior to installing cables and wiring systems.

H. Provide raceway support in intervals not exceeding the maximum spacing per NEC.

3.02 INSTALLATION - CONDUIT

A. Install raceway and conduit system from point of origin in outlets shown, complete with offsets, pull boxes, junction boxes and fittings.

B. Installation of all new conduits must be minimum 12 inches from ceiling grid except where approved by Owner.

C. No raceway shall be run horizontally inside of walls or partitions. Exceptions: building perimeter walls under windows, clerestory panel walls, and where structural conditions do not allow vertical access to tops of walls. The contractor shall obtain written approval from the Owner for exceptions prior to installation.

D. Install rigid wall hot-dipped galvanized steel conduit. Minimum size shall be ½-inch unless noted otherwise on the Drawings. Minimum size for communication shall be 1-inch. The following exceptions are permitted:

1. Electrical Metallic Tubing (EMT): In sizes ½-inch up to and including 4 inches, may be used inside dry locations where not subject to mechanical damage. ½-inch EMT may only be used for connections between distribution J-boxes in the ceiling and J-boxes in the walls within the same room, serving 15-20 Amp single phase receptacles, lighting occupancy sensors, switches, dimmers, and fire alarm respectively. In such application the length of ½-inch EMT shall not exceed 25 feet. EMT shall be used in air-conditioned spaces, such as accessible ceilings, and dry wall partitions. EMT shall not be used outside, in concrete, underground, in underfloor spaces, in masonry walls and in locations likely to be damp. EMT shall not be used for circuits with system voltage over 480 volts.

2. Liquid-tight Flexible Metal Conduit:
   a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install internal ground wire on flexible conduit with grounding bushings.
   b. Maximum length shall be four (4) feet, minimum two (2) feet; minimum size shall be ½-inch.

3. Flexible Metal Conduit:
   a. Where required, install standard flexible steel metal conduit (not liquid-tight) with internal ground wire, in spaces above ceilings.
b. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. All flexible conduits shall be supported per NEC except for lighting whips and vibration isolation conduits. Maximum length shall be four (4) feet, minimum two (2) feet; minimum size shall be ½-inch.

c. Communication flexible conduit size in walls shall be minimum 1-inch.

d. Flexible conduit for lay-in fixtures may be 3/8-inch factory whip assemblies (6 feet maximum).

e. Flexible conduit for receptacles in office applications can be used in the walls as long as the flexible conduit length does not exceed 12 feet and the flexible conduit run is not horizontal. Where fished in existing walls, the length shall not exceed 12 feet.

4. PVC Conduit:

a. Utilize PVC conduit for underground outdoor installations, minimum size 1-inch. All PVC conduit runs shall have PVC coated rigid steel stub outs from the ground, including the last 90 degree bend.

b. All underground PVC conduit shall be installed in concrete with 12-inch x 12-inch x 3-inch concrete markers at every 100 feet and at every turn in direction.

c. All underground conduits shall be encased in concrete and shall have their locations identified by a warning tape that is placed in the trench at least 12 inches above the underground installation. Provide trace wire for major underground feeders.

d. Warning tape. Underground cable and conduit detectable marking tape shall be 6 inches wide, red with black letters, imprinted with “CAUTION – BURIED ELECTRIC CABLE BELOW” or similar. Tape shall be installed a minimum of 12 inches above the underground installation, and not more than 12 inches below finished grade. Warning tape shall be visible at the point where the conduit emerges above ground at the service stubs. Where fiber optic cable is to be installed in the conduit, an underground cable marking tape with a metallic detection strip shall be imprinted with ‘CAUTION – BURIED FIBER OPTIC CABLE BELOW’ or similar. Splicing of the tape shall be accomplished with metal clips to maintain electrical continuity along the length of the tape. Splices shall be wrapped with a waterproof adhesive tape.

5. PVC Coated Rigid Steel Conduit:

a. PVC coated rigid steel conduit may be direct burial for underground installation when concrete encasement is not required.

b. The PVC coated conduit shall be hot dip galvanized inside and out. The PVC coated conduit factory-cut threads shall be protected with hot galvanized threads and a clear urethane coating. Thread protectors shall be used on the exposed threads of the PVC coated conduit. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid galvanized steel conduit. The PVC coated rigid galvanized steel conduit must be certified and authorized to wear the ETL Verification Mark.

c. Ferrous fittings for general service locations must be UL Listed with PVC as the primary corrosion protection.
d. A PVC sealing sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening, except unions. The inside sealing sleeve diameter shall be matched to the outside diameter of the conduit.

E. Multiple Conduit Installation:

1. Install all conduits parallel to or at 90 degrees to the structure. Multiple conduits shall not be installed using a single rod support. Multiple conduits running the same direction with spacing 48 inches apart or less shall be installed on the same trapeze. Conduits shall be installed on metal framing constructed trapeze hangers that have minimum 24-inch width. Trapeze hangers shall be supported on minimum 3/8-inch diameter all-thread rod attached to the structure with coupling nuts and expansion bolts or beam clamps. Conduit straps or other devices specifically designed for the purpose shall be used to secure conduits to the metal framing. Wire ties and hanger wires are not permitted. Conduits shall only be installed on the top surface of the metal framing, with multiple layered trapeze supports if required. Hanger rods shall not extend more than 1 inch past the lower trapeze metal framing. Use double nuts for all-thread rods.

2. Where parallel conduits are strapped, fastened or anchored, the devices used shall be of the same type and installed on the same plane whether vertical or horizontal.

3. Conduit hangers from drop rod (like Caddy B18 Series) are acceptable only upon prior written approval from the Owner.

F. Single Conduit Installation:

1. Install single conduits parallel to or at 90 degrees to the structure and suspended from the structure on all thread rods (1/4-inch minimum) or clamped and/or clipped to the structure with manufactured clamps/ clips. When single conduits are suspended from all thread rods, conduit clamps with bolts and nuts shall be used. Through partition wall penetration shall not be construed as a means of conduit support. Wire ties and hanger wires are not permitted. No powder actuated, compressed air, propane or similar powered “shot” anchor systems shall be installed under any circumstance. Wire ties and hanger wires are not permitted. Single conduits may be secured as follows:

   a. Wood screws on wood.
   b. Toggle bolts on hollow masonry.
   c. Bolts and expansion anchors in concrete or brick.
   d. Machine screws, threaded rods and clamps on steel.
   e. Conduit clips on steel joists.
   f. Plastic anchors are not allowed.
   g. Conduit hangers from drop rod (like Caddy B18 Series) are acceptable only upon prior written approval from the Owner.

G. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductor of appropriate ampacity. Leave termination of such jumpers exposed. Conduit and wireway systems shall not serve as branch circuit grounding conductors.

H. Install expansion fittings in metal conduit as follows:
1. Conduit Crossing Building Expansion Joints:
   a. EMT all sizes.
   b. Rigid Galvanized Steel (RGS) all sizes.

2. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.

3. Provide conduit expansion fitting with an integral bonding braid, as in Crouse-Hinds Type XC.

4. Expansion fittings are not required where offsets, expansion loops, or flexible conduit are placed in conduit runs.

I. Install conduit concealed in walls, partitions and above ceilings. Install exposed in overhead conduit (at structure) of mechanical rooms and in other similar rooms where ceilings are not provided.

J. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

K. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

L. Install pull wires in empty conduits. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Jetline 232 or equal by Greenlee. Leave at least 12 inches of slack at each end of pull wire.

M. Cap ends of spare conduits and extend into space above accessible ceiling a minimum of 18 inches. Label conduit as spare.

N. Do not daisy chain conduit installations in or on walls, provide a single conduit wall drop per device.

O. The support means for conduit installation, whether threaded rods, trapeze or other system, shall not be shared with non-electrical system. Any deviation from this standard due to space constrain shall be submitted to the Owner. Owner's review does not necessarily guarantee an approval; therefore the Contractor is advised not to start installation prior to final approval.

3.03 INSTALLATION - WIREWAYS AND TERMINAL BOXES

A. Bolt wireways and terminal boxes to steel channels fastened to the wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight wireway.

C. Mount rain-tight wireway in horizontal position only.

3.04 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required for wire pulling, equipment connection, and code compliance. Electrical box locations shown on Drawings are approximate unless dimensioned. Verify location of outlets prior to rough in. Locate and install boxes to allow access and clearances per NEC.
B. J-boxes shall be provided for branch circuits in excess of 100 feet.

C. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal strap for supporting outlet boxes. Accessories shall be compatible with outlet boxes being used and shall meet requirements of individual situations.

D. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation in non-fire-rated walls. Provide minimum 24-inch horizontal separation in acoustic-rated walls.

E. Membrane penetration of minimum 1-hour, up to maximum 2-hour fire rating walls and partitions by recessed steel electrical boxes that do not exceed 16 square inches in area are permitted, provided the aggregate area of the openings does not exceed 100 square inches in any 100 square feet of wall area. The annular space between the wall membrane and the box shall not exceed 1/8 inch. Such boxes on opposite sides of the wall or partition shall be either separated by a horizontal distance of not less than 24 inches or separated by protecting both boxes by listed putty pads or other listed materials and methods.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.

G. Provide knockout plugs for unused openings.

H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Outlet boxes in plaster partitions shall be “shallow-type” set flush in wall so there is at least 5/8-inch plaster covering back of box.

K. Switch boxes shall not be used as junction boxes.

L. Typical outlet box centerline heights shall be as listed in the following table. Coordinate outlet heights with Architectural Drawings, millwork details, casework details and equipment installation. Where discrepancies occur, ask for an interpretation from the Architect/Engineer and Owner.

<table>
<thead>
<tr>
<th>Function</th>
<th>Receptacles</th>
<th>Telecommunications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>18-inches</td>
<td>18-inches</td>
</tr>
<tr>
<td>Corridors</td>
<td>18-inches</td>
<td>48-inches</td>
</tr>
<tr>
<td>Exam Rooms</td>
<td>48 or 18-inches</td>
<td>48 or 18-inches</td>
</tr>
<tr>
<td>Millwork</td>
<td>Coordinate with millwork</td>
<td>Coordinate with millwork</td>
</tr>
<tr>
<td>Casework</td>
<td>Coordinate with millwork</td>
<td>Coordinate with millwork</td>
</tr>
<tr>
<td>Headwalls</td>
<td>Refer to Architectural Drawings</td>
<td>Refer to Architectural Drawings</td>
</tr>
<tr>
<td>Mechanical/Electrical Equipment Rooms</td>
<td>48-inches</td>
<td>48-inches</td>
</tr>
<tr>
<td>Laboratories</td>
<td>Coordinate with casework</td>
<td>Coordinate with casework</td>
</tr>
</tbody>
</table>

M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaires, to be accessible through luminaire ceiling opening.
N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures with separate supports, not from acoustic ceiling or ceiling tile wire. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and to provide a workable neat installation.

O. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

P. Support pull and junction boxes independent of conduit. Combination box/conduit hangers from drop rod (like Caddy B18 Series) are acceptable only upon prior written approval from the Owner.

Q. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations. Set floor boxes level, and adjust floor box flush with finish flooring material.

3.05 INSTALLATION - CABLE TRAY

A. Coordinate cable tray installation with piping ductwork and light fixture installation. Maintain clearance inside cable tray for installation of cables. Install according to manufacturer’s instructions. Provide “Caution - Do Not Use As Walkway” signs suitably displayed as designated by the Owner.

B. Avoid proximity to light fixture ballast (minimum 12-inch clearance) since electronic fields can cause interference with some telecommunication signals.

3.06 INSTALLATION - SURFACE METAL RACEWAYS

A. All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer’s installation sheets. All unused raceway openings shall be closed.

B. Install raceways above ceilings, exposed, on walls and casework parallel to or at right angles to structure and casework. Securely support raceway at intervals not exceeding 10 feet or in accordance with manufacturer’s recommendations.

C. The number of conductors installed in any raceway shall not be greater than the number for which the raceway is approved.

D. Maintain grounding continuity between raceway components to provide a continuous grounding path by means of separate insulated code-size grounding conductors.

   1. Each equipment grounding conductor in a conduit homerun entering the raceway shall be connected to the ground terminals of the receptacles.

END OF SECTION 26 05 33
SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section specifies the requirements for wiring devices (wall switches, receptacles, device plate covers, wall dimmers).

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. NEMA WD 1 - General-Purpose Wiring Devices.
2. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.
3. NEMA WD 5 - Specific-Purpose wiring Devices.
4. Americans with Disabilities Act (ADA).
5. ANSI/UL 20 - General Use Snap Switches.
6. ANSI/UL 498 - Attachment Plugs and Receptacles.
7. ANSI/UL 943- Ground Fault Circuit Interrupters.

1.04 SUBMITTALS

A. Product Data:

1. Submit manufacturer's product data for all wiring devices and floor boxes.
PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide factory fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated provide proper selection to correspond with branch circuit wiring and overcurrent protection.

C. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

2.02 MANUFACTURERS

A. Wall Dimmers:
   1. Lutron.
   2. Leviton.

B. Lighting Occupancy Sensors:
   1. Leviton.
   2. Cooper.
   3. Other manufacturers as specifically approved in writing by Owner.

2.03 WALL SWITCHES

A. Type: Quiet type, back and side wired switches as specified herein.

B. Rating: 20 amperes, 120/277 volts.


D. Manufacturers: Provide devices in the color as specified herein.

<table>
<thead>
<tr>
<th>Type</th>
<th>Pass &amp; Seymour</th>
<th>Arrow Hart</th>
<th>Leviton</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>20AC1</td>
<td>1991</td>
<td>1221-2</td>
</tr>
<tr>
<td>S2</td>
<td>20AC2</td>
<td>1992</td>
<td>1222-2</td>
</tr>
<tr>
<td>S3</td>
<td>20AC3</td>
<td>1993</td>
<td>1223-2</td>
</tr>
<tr>
<td>S4</td>
<td>20AC4</td>
<td>1994</td>
<td>1224-2</td>
</tr>
</tbody>
</table>

*Provide color designation for designated use.

2.04 RECEPTACLES

A. Type: Hospital Grade, where identified on Drawings. Back and side wired receptacles, as specified herein.

B. Rating: Scheduled on Drawings.

D. Provide devices in the color as specified herein.

<table>
<thead>
<tr>
<th>NEMA Configuration</th>
<th>Pass &amp; Seymour</th>
<th>Arrow Hart</th>
<th>Leviton</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-20R (Duplex)</td>
<td>8300</td>
<td>8300</td>
<td>8300</td>
</tr>
<tr>
<td>5-20R (Single)</td>
<td>9301-HG</td>
<td>8301</td>
<td>8310</td>
</tr>
<tr>
<td>5-20R (Tamper Resistant)</td>
<td>SG-3-H</td>
<td>TR-83</td>
<td>......</td>
</tr>
<tr>
<td>GFCI</td>
<td>2091-SHG</td>
<td>GF-8300</td>
<td>6898-HG</td>
</tr>
</tbody>
</table>

*Provide color designation for designated use.

E. All receptacles within six (6) feet of a water source such as sinks shall be a GFCI receptacle. Feed through to non-GFCI receptacles is not permitted.

2.05 DEVICE PLATES

A. Laboratories and Patient Care Areas: Use 302 stainless steel.

B. Finished Office Areas: Nylon in color as selected by Architect.

C. Exposed Boxes in Dry Interior Spaces:
   1. Manufacture plates of heavy cadmium-plated sheet steel.
   2. Edges of plates must be flush with edges of boxes.

D. Other Areas:
   1. Use weatherproof device plates.
   2. Provide cast plates with gasketed spring door covers for protection of device.

E. For outlets and switches, provide labeled nameplates listing power source and circuit number. Example: P10 for panel "P" circuit "10". Label to be tape type black letters on white for normal power and red on white for all generator/emergency circuits.

F. Covers for outlets outdoors shall meet the requirements of latest NEC.

2.06 DEVICE COLOR

A. All switches shall be white except as follows: Red switches shall be used on all equipment and circuits connected to emergency power.

B. Normal power receptacles shall be white and receptacles connected to the emergency electrical circuits shall be red.

C. In laboratories, normal power receptacles shall have alternating colors for different circuits (gray, brown and white).

D. Isolated ground receptacles shall be orange.

2.07 WALL DIMMERS

A. Wall dimmers shall be linear slide type equal to Lutron Nova Series.
B. Dimmers shall be 600 watts minimum, incandescent, larger size as required to accommodate greater connected loads.

2.08 LIGHT OCCUPANCY SENSORS

A. Lighting occupancy sensors shall be installed as a functioning system per the Contract Documents and manufacturer’s installation instructions.

B. Proper commissioning shall be completed prior to Substantial Completion.

C. Ultrasonic motion detectors shall not be used in vivarium corridors.

2.09 TELECOMMUNICATION OUTLETS

A. Telecommunication outlets, boxes, sleeves and conduit are part of this Contract.

B. Provide outlet boxes and 1-inch conduit with connector and bushing to accessible location above the ceiling.

C. Provide a pull string in each conduit and tie off pull string above ceiling.

D. For floor outlets, provide 1-inch conduit to accessible location above the ceiling on the floor served by the outlet. Cabling and devices by MD Anderson.

PART 3 - EXECUTION

3.01 PREPARATION

A. Contractor must examine the areas and conditions under which wiring devices are to be installed and notify the Owner’s Project Manager in writing of conditions detrimental to the proper and timely completion of the Work.

B. Inspect devices for physical damage.

C. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Wall switch and receptacle ground wiring shall terminate at the wiring device with an insulated tin-plated copper spade compression terminal. Select a spade terminal compatible with the wiring devices supplied so that device screw terminals can be torqued to the wiring device manufacturer’s recommendations.

D. Wall receptacles shall be installed with the ground pinhole in the up position, unless instructed otherwise by the Owner.
E. The approximate location of switches and receptacles are indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the architectural Drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Owner’s Project Manager.

F. Install wall switches 48 inches above finished floor, OFF position down.

G. Install wall dimmers 48 inches above floor; derate ganged dimmers as instructed by manufacturer; do not use common neutral.

H. Where wainscot is near the 48 inch level, install device in the wall below the top edge of the wainscot and as near the 48 inch level as possible to provide the most pleasing appearance. Do not partially install devices in the wainscot and partially in the wall.

I. Where shown the strike side of doors, install switches and dimmers not less than 2 inches and not more than 12 inches from door trim, but in all cases as close to the 2 inch setback as possible.

J. Verify all doors swings before rough-in and locate switches and dimmers on strike side of door wherever possible.

K. Position the center of convenience, telephone, computer and TV outlets 18 inches above floor or 8 inches above countertops unless otherwise noted. Coordinate with equipment and architectural Drawings. Install outlets vertically on walls and horizontally above countertops.

L. Install specific-use receptacles at heights shown on Drawings.

END OF SECTION 26 27 26
SECTION 26 51 00 – LIGHTING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section specifies requirements for indoor and outdoor lighting fixtures, exit signs, lamps and ballasts.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:


2. NEMA WD1 - General-Purpose Wiring Devices.

3. ANSI C82.1 - Specification for Fluorescent Lamp Ballasts.

4. ANSI C82.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type).


1.04 SUBMITTALS

A. Product Data:

1. Submit a 3-ring binder with manufacturer’s data on lighting fixtures in booklet form, with a separate sheet for each fixture, assembled by luminaire “type” in alphabetical order, with the proposed fixture and accessories clearly labeled. Ballast and lamp product data shall accompany fixture submittals.
B. Record Documents:

1. Submit dimensioned drawings and performance data including coefficients of utilization, candelas distribution, spacing to mounting height ratio, efficiency and visual comfort probability for each fixture, assembled by luminaire type in alphabetical order.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers. Parabolic louvers shall be shipped in thermally sealed polyethylene wrapper.

B. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store product in a clean, dry space protected from weather.

1.06 EXTRA MATERIALS

A. Refer to Section 01 78 46 for Maintenance Material Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Lighting fixtures and accessories shall comply with the design and functional requirements of the Project. Design characteristics shall be as noted in manufacturer's submittal data.

C. Provide lighting fixtures of the size, type and rating as scheduled, complete with, but not limited to, lamps, lamp holders, reflectors, ballasts, and wiring.

2.02 MANUFACTURERS

A. Emergency Exit Signs:

1. Lithonia.
2. Sure-lites.
3. Emergi-Lite.

B. Lamps:

1. Philips.
2. Osram Sylvania.

C. Ballasts:

1. Universal Lighting Technologies.
2. Advance.
3. Osram/Sylvania.
4. Lutron.
5. Robertson Transformer.

2.03 INTERIOR LIGHTING FIXTURES

A. Linear Fluorescent Fixtures:
   1. Lenses shall be minimum 0.140-inch-thick virgin acrylic. Lens pattern shall be KSH 20 or approved substitution.
   2. Parabolic louvers shall have a low iridescent diffuse silver finish, 3-inch deep, 6-cells per 4-foot lamp.
   3. Frames shall be flush or regressed, aluminum, steel hinged and equipped with rotary-action cam latches. Spring latches are not acceptable. Frames shall be reversible and capable of latching either side.

B. Compact Fluorescent Fixtures:
   1. Reflectors shall be clear, with integral white trim ring, unless noted otherwise.
   2. Open reflectors shall be 7-inch minimum diameter.
   3. Fixtures installed outdoors and over food handling areas shall be lensed.
   4. Fixtures installed in shower locations shall be provided with flush type plastic reflector with opal lens.

C. Incandescent downlight fixtures shall be prewired equipped with integral thermal protection.

D. Special Application and Function:
   1. Teleconferencing areas shall have fixtures which match, and are compatible with existing facility installations, including lamp type, lamp color, fixture and lens type, controls, and minimum lighting levels for the vertical and horizontal planes. Coordination shall be with Owner’s Telehealth Services section of UTTV.
   2. Low voltage fixtures utilizing MR16 lamps shall be lensed.
   3. 'Clean-room' type fixtures for high purity areas and special laboratory functions shall be triple gasketed, with sealed cam latches.
   4. Warning signs (In Use, Beam On, X-Ray In Use, etc.) shall be LED illuminated with housing and face color as specified.
   5. Task lights shall be equipped with an integral rocker switch. Where two or more task lights are located in a room, a wall switch shall be installed at the entry door for control.
2.04 ENVIRONMENTAL ROOMS AND EXTERIOR LIGHTING FIXTURES

A. Enclosures shall be complete with gaskets to form weatherproof seal and UL approved for wet locations.

B. Provide low temperature ballasts with reliable starting to 0 degrees F.

C. In-ground or buried fixture and ballast systems are not approved for use.

D. Exterior fixtures shall match Owner’s existing style and types, particularly bollard, pole-top, parking garage, soffit, roadway, perimeter area lights and landscaping types. Exterior fixtures shall be compatible with Texas Medical Center (TMC) standards as applicable.

2.05 RETURN AIR TROFFER

A. The return air troffer where indicated on Drawings, shall have white enamel finish, 0.140 inch clear prismatic acrylic lens, and shall be recessed in inverted "T" bar ceiling. Lens pattern KSH 20 or approved substitution.

B. The return air troffer shall have the capacity to handle 200 CFM of return air through the side slots of the nominal 4-foot long fixture (without return air attachment) with a total pressure drop from the rooms to the return air ceiling plenum not to exceed 0.05 inches w.g.

2.06 EMERGENCY EXIT SIGNS

A. Provide exit signs with red LED illumination.

B. Exit signs shall have covers that are composed of a black face and body, smooth red diffusion material, with 6 inch-high red letters on black background, directional arrows as indicated. Individual LED's shall not be visible through the diffusion material.

C. Fixtures shall have minimum five (5) year warranty.

D. Fixtures shall be UL924 and Energy Star compliant.

E. Exit signs shall be rated for dual voltage; 120/277.

2.07 LAMPS

A. Incandescent lamps shall be used only when specified in the Construction Documents and approved for use by Owner’s Representative.

B. Pin-based compact fluorescent lamps shall be quad or triple tube, 13, 18, 26 or 32 watt similar to NEMA lamp type CFQ13W/G24Q/835 or CFTR26W/GX24Q/835. ‘Long’ compact fluorescent lamps in nominal 39 and 40 watt sizes are acceptable. Compact fluorescent lamps shall be 3500K color temperature. Original equipment manufacturer lamps that are only available from a single manufacturer are not acceptable.
C. Linear fluorescent rapid or instant-start lamps shall be medium bi-pin equal to or better than Philips T-8 lamps, minimum CRI of 85. General use four foot lamps shall be equal to or better than Philips Energy Advantage F32T8/ADV841/XEW/ALTO. If different lamp manufacturers are submitted, no noticeable difference in color temperature shall be allowed and performance shall be equal to or better than the base lamp. T-8 fluorescent lamps shall have a color temperature of 4100 K and be specified in 2 foot, 3 foot and 4 foot lengths only. U-bent (6 inch, 3 inch and 1-5/8 inch) and circline lamps are not acceptable. Linear four foot lamps used in open fixtures in environments below 70 degrees F, or in operation rooms, shall be full wattage type.

D. Metal halide HID lamps shall be ceramic metal halide type, clear, unless noted otherwise, with mogul or medium bases. Acceptable medium base lamp sizes are 50, 100 and 150 watts. Double-ended lamps are not acceptable. Any base type other than medium or mogul shall be submitted for Owner review and approval in advance. Metal halide fixtures shall be lensed or utilize a lamp (PAR type) which does not require special arc tube protection.

E. Cold cathode, neon, T-5 and T-2 systems are not approved for use.

F. LED, induction and fiber optic lighting systems may be approved for special applications when submitted for Owner review and approval in advance.

G. Lamps, including linear fluorescent, compact fluorescent and high intensity discharge, shall be low mercury type and shall pass all federal TCLP (Toxicity Characteristic Leaching Procedure) test requirements at the time of manufacture.

2.08 BALLASTS FOR FLUORESCENT T-8 LAMPS

A. High frequency (20 kHz or greater) electronic type.

B. THD (total harmonic distortion) of less than 10 percent.

C. Power factor greater than or equal to 95 percent.

D. Ballasts shall operate with 265 MA lamps.

E. Unless noted otherwise (i.e. dual switching, etc.), provide one ballast per fixture.

F. All ballasts shall be rated for 277-volt operation except for under-counter, patient headwall, and patient room night light fixtures that shall be rated for 120-volt operation.

G. Ballasts shall be Class P thermally protected.

H. Ballasts shall include a 5-year manufacturer's warranty.

I. Ballasts shall meet FCC requirements governing electromagnetic and radio frequency interference.

2.09 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. All ballasts shall be of the high power factor type and be capable of independent switching if two ballasts are provided with a fixture.

B. Ballasts shall include a 5-year manufacturer's warranty.
C. Dimming ballasts shall be electronic and compatible for line voltage or control wire dimming systems as specified on the Contract Documents.

D. Ballasts shall be magnetic for 2-pin lamp application. Electronic ballasts for other applications shall be submitted for Owner approval in advance.

2.10 BALLASTS FOR HID LAMPS

A. HID ballast shall be of the lead-peak autotransformer type for metal halide lamps. Ballast shall start and operate the lamp at ambient temperatures ranging from minus 20 degrees F to 105 degrees F. All ballasts shall have automatic thermal protection, and high power factor, minimum of 90 percent. Ballasts for interior applications shall be encased and potted, or be of the electronic type.

B. HID ballasts for M90, M110, M130, M139 and M140 rated lamps shall be electronic, and shall include a five (5) year manufacturer’s warranty.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Install light fixtures in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association’s "Standard of Installation".

C. If a fixture type designation is omitted, furnish fixture of the same type as shown for rooms of similar usage. Verify with Owner’s Project Manager before purchase and installation.

D. Check the building electrical system requirements and architectural finishes. Regardless of the catalog number prefixes and suffixes shown, furnish fixtures with the proper trim, frames, supports, hangers, ballasts, voltage rating, and other miscellaneous appurtenances to properly coordinate with Project conditions. Verify with Owner’s Project Manager prior to ordering.

E. Check the type of ceilings to be installed in each room and verify that the recessed light fixtures are proper for the type of ceiling to be installed before ordering fixtures. Provide a frame compatible with the type of ceiling in which the recessed lighting fixture is installed. Refer to the Architectural Room Finish Schedule for the specified ceiling type.

F. Fixtures shall be securely attached to the ceiling-framing members by mechanical means. Clips identified for use with the type of ceiling framing member(s) and fixture(s) shall also be permitted. Fasten lighting fixtures in areas where there is no ceiling securely to the structure.

G. Immediately before final observation, clean all fixtures, inside and out, including plastics and glassware, and adjust all trim to properly fit adjacent surface, replace broken or damaged parts, and lamp and test all fixtures for electrical as well as mechanical operation.

H. Protect installed fixtures from damage during the remainder of the construction period.

I. Wiring methods:
1. Lighting fixtures shall be connected to a typical metal conduit, junction box, and wire lighting grid system. MC (Metal-Clad Cable) and FMC (Flexible Metal Conduit), where are permitted to be used, shall be concealed to prevent physical damage. Exposed MC and FMC installations are not acceptable.

2. Modular cabling, flexible whip assemblies, feed through wiring, ‘daisy-chain’ feeds, tandem wiring and other similar wiring methods are not acceptable for the lighting circuit distribution and wiring system.

3.02 TESTING

A. Upon completion of installation of interior lighting fixtures, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the Project Site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

B. Incandescent lamps shall be new at time of Final Completion.

C. Fluorescent lamps may be used in the final finishing of the Project. Those that have exceeded more than 20 percent of their rated life (as established by Owner records) or that have darkened ends shall be replaced with new lamps before Final Completion.

D. HID lamps may be used in the final finishing of the Project. Those that have exceeded more than 20 percent of their rated life (as established by Owner records) shall be replaced with new lamps before Final Completion.

E. All existing fixtures in work area that are re-used or relocated shall be cleaned inside and out, broken or damaged parts replaced and new lamps installed.

3.03 LIGHTING FIXTURE SCHEDULE

A. Refer to Lighting Fixture Schedule on Drawings for list of specified manufacturers for each fixture proposed.
SECTION 28 30 00 – FIRE ALARM AND SMOKE DETECTOR SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. The Work covered by this Section of the Specifications shall include the furnishing of all engineering, labor, materials, transportation, tools and appliances required in the performance of all operations required for the installation of a complete, fully functional and code compliant fire alarm system or system modification in the areas listed.

B. The fire alarm system contractor must provide a system design which meets all applicable codes and all requirements of these specifications, even when those requirements are specifically in excess of minimum code requirements. Note that engineering drawings are conceptual and provide for infrastructure and basic layout of the system. The fire alarm system contractor must check the provided layout and augment the design as needed to provide a compliant system. Any design inconsistencies or conflicts within this document must be resolved through the Request For Information process. All fire alarm system related RFI’s must be reviewed by the Environmental Health and Safety Department.

C. The contractor must certify the documents they produce meet and comply with all applicable codes and the system is designed in accordance with said codes. Noting non-compliance on drawings or documents is not acceptable. Any design inconsistencies or conflicts within this document must be resolved through the RFI process.

D. The term “Owner” shall include a representative from the MD Anderson Cancer Center (MD ACC) Environmental Health and Safety (EH&S) department but is not limited to represent the Owner exclusively. Coordinate all activities to include all of the Owner’s representatives.

E. The Contractor shall perform all Work in accordance with the Drawings and Specifications, and subject to the terms and conditions of the Contract.

F. The approximate locations of related devices are indicated on original Drawings. These Drawings are not intended to give complete and exact details in regard to location of devices, apparatus, etc. Exact device locations and quantity are to be determined by actual measurement at the building and will in all cases be subject to the approval of the Owner. All drawing location changes, additions or deletions shall be made by a licensed fire protection engineer or licensed fire alarm planner representing the fire alarm systems Contractor, and approved by the Owner. The Owner reserves the right to make any reasonable changes in the locations indicated without additional cost. When making changes to existing systems, the record drawing for the area modified shall be updated and the updated record drawing provided to the Owner.
G. No Work shall be performed until the Shop Drawings, calculations, and product data have been approved by the MD Anderson Cancer Center (MD Anderson) Environmental Health and Safety (EH&S) department. This will require early processing of all submittals. The Contractor is solely liable for any or material purchases made prior to this approval.

H. All existing fire alarm equipment, wiring, devices and sub-systems that are not shown to be reused shall be removed. All existing fire alarm conduit not shown to be reused shall be removed.

I. Fire alarm system components removed for construction shall not be reused. Fire alarm system components removed for construction shall not be indicated as existing on shop drawings.

J. Contractor shall deliver all serviceable equipment removed to the Environmental Health and Safety Department.

K. Where these specifications are edited for a specific project the edits shall be reviewed for code compliance and system compatibility by EH&S.

L. Contractor is responsible for all tools and equipment needed to perform the entire scope of work. Tools and equipment include but are not limited to ladders, scaffolding, lifts, containment cubes, barricades, safety equipment, meters, analyzers, and work carts.

1.03 TEMPORARY PROTECTION

A. It is the intention of this section to provide for temporary fire alarm detection and notification functions in construction areas. The temporary system when installed and tested will allow for demolition of all existing fire alarm devices raceways and wiring, as required by the project scope, without need for further demolition of fire alarm system components prior to installing new raceways, wiring and devices.

B. Fire alarm contractor shall submit a hard copy of a drawing of the proposed temporary system for review by EH&S.

C. Where modifications to existing fire alarm devices or equipment cause Interim Life Safety Measures to remain in place for a period of time exceeding 48 hours, temporary protection shall be provided to the affected area.

D. Temporary systems shall include detection devices such as heat detectors, notification devices and control devices as required to adequately serve the construction area.

E. Manual alarm stations shall be installed at construction exits where egress pathways do not have an existing manual station within fifty feet of the construction exit.

F. Where detection devices are located on the ceiling of the construction area, twenty four inches of yellow caution tape will be affixed to the wiring serving a device within six inches of the device to provide a locator of the temporary detection device. Yellow tape shall not be used for locating or identifying other ceiling mounted devices so as not to detract from detection device locators.

G. Existing conduit, raceways and devices not shown to be reused shall not be used to serve the temporary system devices.

H. Temporary systems shall include wiring to active fire alarm devices beyond the construction area to allow for complete demolition of existing raceways.
I. Temporary protection devices shall be installed in mounting boxes and secured to building structure.

J. All wiring connections of the temporary system shall be made in junction boxes. All junction boxes shall be covered and labeled.

K. Temporary protection installations shall be fully tested and certified by the installing contractor.

L. Temporary protection installations shall be presented to the Environmental Health and Safety Department for acceptance before demolition or shutdown of the existing fire alarm system or devices.

M. Temporary protection shall be left in place until the new fire alarm equipment has been tested and certified compliant and operational by the installing contractor and accepted by the owner.

N. Temporary protection shall resemble the description in Attachment “E”.

O. Where existing fire alarm system devices are used to provide protection in the construction area, they shall not be removed until the new devices have been tested and certified compliant by the installing contractor and accepted by the Environmental Health and Safety Department.

P. All fire alarm system devices providing protection to construction areas are to be maintained fully functional and compliant at all times. Junction boxes to remain closed at all times.

Q. Temporary system shall comply with all other sections of these specifications.

1.04 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. All Work shall comply with the applicable rules of the National Fire Protection Association, National Electrical Safety Codes, and Ordinances as well as any other authorities that have lawful jurisdiction pertaining to the Work specified herein. None of the terms or provisions of this Specification shall be construed as waiving any of the rules, regulations or requirements of said authorities.

2. Contractor shall comply with the Texas Insurance Code Article 5.43-2 Fire Detection and Alarm Devices and Title 28 TAC 34.600 the Fire Alarm Rules

3. The complete installation is to conform to the applicable sections of NFPA 72, NFPA 90A, NFPA 99. Local Code Requirements, NFPA 70 the National Electrical Code with particular attention to Article 760.

4. Additionally, the entire installed system and all integrated system operations shall be within the guidelines of International Building Code, and the American with Disabilities Act, Public Law 101-336.
5. All control equipment shall have transient protection devices to comply with UL864 requirements.

6. The system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits shall be marked in accordance with NEC 760-23.

D. In any instance where these Specifications call for materials or construction of a better quality than required by the codes, the provisions of these Specifications shall take precedence.

1.05 QUALITY ASSURANCE

A. Each and all items of the fire alarm system shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters’ Laboratories, Inc. (UL), and shall bear the “U.L.” label. All control equipment shall be listed under both UL category UOJZ Control Units System as a single unit and under UL category APOU Proprietary Alarm Units. Service under APOU shall be Grade A. Partial listings, or multiple listings for various major sections of the control, shall not be acceptable.

B. The installation shall be performed by a company specializing in installing the products specified in this Section with a minimum of five years of experience, and certified by the State of Texas as fire alarm installers.

1.06 SUBMITTALS

A. General:

1. Submittals must conform to requirements of Section 26 01 00 and Division 01.

2. The contractor shall furnish a full sized hard copy of the entire fire alarm submittal, with drawings, to the Environment Health and safety Department for review. This hard copy shall be in addition to any on line, database or electronic version requirements. No revised shop drawings are to be delivered to the field without prior review of the revisions by EH&S.

3. If the original submittal or any subsequent submittal is not accepted by the Environmental Health and Safety Department, a resubmission of a hard copy of the entire fire alarm submittal must be provided to the Environment Health and safety Department for further review.

4. The fire alarm system shall comply with these specifications and all applicable codes. Acceptance of the fire alarm system submittal does not exempt the contractor from full compliance with the contract documents.

5. An electronic version of the submittal shall be provided.

6. Submittals shall include the MD Anderson project number on the cover page.

7. All products submitted shall conform to all aspects of these Specifications. Non conforming products may cause the submittal to be rejected.

8. Submittals shall include device installation instructions as well as the product data sheets to allow for verification of compliance with NFPA 70.760.130 B & 70.110 .3 B.

9. Submittal shall include description of warranty service indicating compliance with all warranty requirements specified in this document.
10. Contractor shall not submit disclaimers or exclusions which may result in a fire alarm system which is not complete, or a fire alarm system which is not fully operational, or a fire alarm system which is not code compliant, or a fire alarm system which does not comply with these specifications. Disclaimers which conflict with these specifications shall not be considered valid.

11. Submittals shall include any requests for information (RFIs) and the responses to the requests. Unsigned or unidentified responses are not valid.

12. Submittals shall include a list of manufacturer representatives responsible for the design, installation and service of the installation.

13. Contractor shall not submit equipment for which the contractor does not maintain a local stock which is immediately available for service requirements.

B. Furnish information on the complete scope of work including:

1. Design and engineering responsibilities.
2. Equipment and products provided.
3. Installation and start-up details.
5. System certification.

C. Owner's Pricing Detail:

1. Submittal shall include a complete bill of materials listing all material quantities and unit prices identifying components by manufacturer’s part number.
2. Submittal shall include the unit costs and extended costs of each item listed in the bill of materials.
3. Pricing detail shall resemble Attachment “A”.
4. Contractor shall submit separately and directly to Owner a pricing breakdown of all cost associated to Project for review. This is to include but not be limited to material quantity, description, unit list price, multiplier, cost, extended cost, material costs adjustment less Owner’s discount price, outside material price totaled and itemized, itemized subcontract price associated to Project, and total Project support price.
5. Contractor labor hour quantities shall be itemized by mechanical labor, electrical labor, field programming labor and design and management labor. Hour quantities shall be itemized by journeyman rate, technician rate and design/management rate with quantity of hours listed separately. Programming hours shall be listed separately from other hours using the same rate such as panel terminations etc.
6. All estimated overtime shall be disclosed. Profit for Project shall be disclosed. Total Project price shall not exceed the sum of the listed itemized costs.
7. This pricing summary, including any attachments, is intended only for the Owner and contains confidential and/or privileged information. Any unauthorized review; use, disclosure or distribution is prohibited.

8. Where temporary protection devices are included, they shall be labeled as such in the pricing detail.

D. Sequence of Operations:

1. Submittal shall include a complete written sequence of operations of all functions of the system.

2. In addition to the written sequence of operations, all sequence functions shall be depicted using a sequence of operations dot matrix chart of all functions showing how the system will react to the activation of each type of device, as recommended by NFPA 72.

3. The MD Anderson campus consists of multiple buildings using various system matrixes. The submittal must include a matrix which is applicable to the building and scope of work.

4. Submittal shall include details of all interfaced functions. Details shall include all fire alarm system functions and interconnections applicable to each interface. Each individual function shall be referenced in the sequence of operation.

E. Drawings:

1. Prepare drawings using AutoCAD software and include all Contractors’ information. The Contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by the Architect.

2. Drawings shall include title blocks with contractors name, address, telephone number and license number.

3. Drawings shall include a title page with an accurate legend of symbols for all fire alarm devices installed. The legend must include the model and quantity for each device.

4. Floor plans: Provide locations for all devices (with device number at each addressable device corresponding to control unit programming), appliances, panels, power boosters, equipment, junction / terminal cabinets, risers, electrical power connections individual circuit and raceway routing, number size and type of raceways, and conductors in each raceway. Conduit fill calculations with cross section area percent fill for each type of conductor and raceway. Show all interfaces for all fire safety functions.

5. Drawings shall include a reference list of all equipment panels, NAC panels, terminal panels, control panels with areas served and locations indicated by room number.

6. Any devices removed from the fire alarm system during construction shall not be referred to as existing devices on drawings. All devices installed shall be new.

7. Device placement on drawings shall be in accordance with section 3.02 of these specifications.

8. Drawings shall include elevations of all wall mounted equipment.

9. Drawings shall include a list of all remote power supplies including location by room numbers.
10. Raceways and raceway junction boxes shall be indicated on fire alarm shop drawings. Coordination between trades may be necessary.

11. Where junction boxes contain wiring splices the boxes shall be identified on the fire alarm shop drawing.

12. Floor plans shall show the entire project area and connections to existing system. All fire alarm devices (new and existing) shall be shown. A demo page may be used to show existing devices.

13. Floor plans shall show room numbers and use for each room.

14. Floor plans shall clearly show and identify all fire or smoke rated walls within the construction area. Coordinate with construction documents.

15. Floor plans shall show details and UL listing numbers of fire stop systems used at all penetrations. Coordinate with construction documents and other trades as necessary.

16. Riser diagrams: Provide, for the entire system, the number, size and type of riser raceways and conductors in each riser raceway and number of each type of device per floor and zone. Show door holder interface, elevator control interface, HVAC shutdown interface, fire extinguishing system interface, and all other fire safety interfaces. Show wire styles on the riser diagram for all circuits. The riser schematic shall show locations of all control panels, transponder cabinets, terminal cabinets, NAC power supplies. Locations shown shall be identified by room number.

17. Detail: Show campus network interface detail including all modems and interconnections necessary for a fully functional network interface.

18. Detail: Show connection to campus voice system and remote speaker circuit selection switches. Include detailed schematic of all components necessary to for a fully functional voice control and delivery system. Show all interconnection details for the integration with the existing voice panel in monitoring services and the voice panel in room R2.2743 indicating which switches will be used for speaker selection, wiring paths connection boxes, modems, equipment etc.

19. Detailed wiring diagrams: Provide for control panels, modules, power supplies, electrical power connections, auxiliary relays, and annunciators showing termination identifications, size and type conductors, circuit boards, LED lamps, indicators, adjustable controls, jumpers, switches, connectors, harnesses terminal strips and connectors. Diagrams shall be drawn to a scale sufficient to show the spatial relationships between components, enclosures and equipment configuration.

20. Prior to performing the final acceptance test the Contractor shall deliver to the Environmental Health and Safety representative: one (1) set of reproducible, Record Drawings two (2) blue line copies and one (1) set of the Record Drawing computer files using AutoCAD. Record Drawings shall show all new and existing conduit and wiring used for the fire alarm system.

21. Contractor shall provide complete system point-to-point wiring diagrams with appropriate terminal designations and schematics for all components provided and for interfaces to equipment and cabling supplied under other Divisions or by the Owner.

22. Drawings shall indicate source of power at each device for any device requiring fire alarm system power for operation.
23. The name of the Fire Alarm System Planner providing the manufacturer’s Drawings.

24. A listing of the manufacturer’s representative responsible for installation, coordination and service.

25. Contractor’s wire marking schedule.

26. When visual notification devices are added to existing systems the submittal shall include a power availability analysis showing the intended source of power, the notification circuit capacity and standby power availability.

27. Submittal shall include battery calculation sheets for all fire alarm control panels and auxiliary power supplies. Battery calculation shall include all electrical requirements of the entire fire alarm system, including the power consumption of the individual devices, both in alarm and supervisory modes.

28. Equipment and design submitted shall comply with all referenced codes and standards. Any deviation from codes and standards must be approved by Owner and documentation of that approval must be included in the submittal.

29. When audible notification devices are added to existing systems the submittal shall include a power availability analysis showing the intended source of audio, the amplifier used, the notification circuit capacity and standby power availability. All manufacturers’ data pertaining to audible circuits such as noise suppression and wiring limitations shall be included in the submittal.

30. Changes to contract drawings shall be submitted to EH&S for review and acceptance. Installation shall be as per the approved drawings only.

31. No revised shop drawings are to be delivered to the field without prior review of the revisions by EH&S.

F. System Design Details:

1. The submitted design shall meet all applicable codes and standards. Contractor shall submit all necessary requests for information to meet this requirement.

2. Submittal shall include voltage-drop calculations for all notification appliance circuits. Maximum voltage drop shall not exceed 10 percent of the system supply voltage.

3. Where voice communication systems are required by code, the voice communications system shall be designed to meet the intelligibility standard.

4. Design shall include identification of all acoustically distinguishable spaces (ADS) and these spaces shall be indicated on the fire alarm system shop drawings. Each ADS shall be identified as requiring or not requiring voice intelligibility.
5. Where stairwell pressurization fan operation requires a Fire Fighters Smoke Control Station called for in NFPA 92A the operation of the Fire Fighters Smoke Control Station may be independent from the Building Fire Alarm System or it may be integrated with the Building Fire Alarm System. The Building Fire Alarm System shall perform all required smoke detection, duct smoke detection and stairwell fan activation in either case. When integrated with the building fire alarm system the Fire Fighters Smoke Control Station shall be detailed in the fire alarm system submittal. Where the Fire Fighters Smoke Control Station is an integral part of the building fire alarm system it shall comply with all additional requirements of NFPA 92A. The Fire Fighters Smoke Control Station shall include separate switches for required manual fan activation and deactivation and separate switches for optional manual override after shutdown from the duct smoke detector. Fire Fighters Smoke Control Station off normal and trouble status shall be indicated on the building fire alarm system. Where the Fire Fighters Smoke Control Station is submitted separately from the building fire alarm system it shall not be directly connected to the building fire alarm system. Interface with a Fire Fighters Smoke Control Station not included in the building fire alarm system submittal shall be interfaced with the Building Fire Alarm System via dry contacts. Fire Fighters Smoke Control Station shall include all field wiring and devices necessary to perform all functions independent from the building fire alarm system.

6. Where power operated doors are required to be interfaced with the fire alarm system, dedicated smoke detectors, installed according to NFPA 72 and section 3.02 of these specifications, detectors for door release shall be used to initiate the signal for deactivation of the manual power open function. This signal is in addition to a general by floor alarm signal which will signal the powered door operator to close the doors. Two separately programmable fire alarm system relays shall be required to provide this feature.

7. Magnetic door holders and automatic door interface relays shall be powered from and controlled by dedicated door control NACs as per section 2.07 H.

8. Where relays are used the relays shall be normally in the non-operated mode and shall activate upon alarm.

9. The submittal shall include detailed description of methods used to ensure compliance with voice intelligibility standard.

10. Where structured cabling method is used, submittal shall include detailed description of the specific method used and a complete list of fittings.

11. All device labels displayed at system control panels and annunciators shall conform to the standard MDACC format listing the building acronym, floor level and room number with corridor or special designator. Example: HMB7.2421 Corr. See attachment “C”. All control points, initiation points panel names etc. shall include location by room number designator.

12. Include room location in all displayed transponder, node, NAC or equipment labels.

13. Contractor shall furnish and install a drawing print hanger and brackets on the wall in the fire command room. The hanger shall have the capacity to accommodate a complete set of fire alarm system drawings thirty inches by forty inches. The top of the hanger brackets shall be at 52 inches above the finished floor. The brackets shall hold the drawings flat against the wall. This requirement applies to new fire command rooms or existing fire command rooms where no brackets or hangers are present.
14. When sprinklers are installed in elevator equipment rooms, the electrical power to the elevator controller must shut down prior to sprinkler activation. A heat detector shall activate an independently controlled shunt trip circuit breaker (provided and installed by the Electrical Contractor) when the temperature in the machine room exceeds the setting of the heat detector. The detector shall have both a lower temperature rating and a higher sensitivity (lower Response Time Index) as compared to the sprinkler. Heat detectors used to shut down elevator power prior to sprinkler operation shall be placed within two (2) feet of each sprinkler head and connected to the fire alarm control panel. Electric power for initiating shunt trip shall be monitored by the fire alarm system at the point where the power is switched by the fire alarm relay. Where multiple shunt trip relays are used, the power at each relay shall be monitored.

15. Where audible notification devices are added to an existing system, the design shall include a power availability analysis showing the intended source of the audio, the amplifier used, the amplifier’s current and proposed power usage, the notification circuit capacity and standby power availability.

16. Where a specialized tone is required in a specific building area, the voice system may be designed with a dedicated amplifier and tone source to provide the specialized tone as an alternative to designing an entire multi-channel system. Such alternative shall have the capability to provide all voice messaging functions.

17. Where fiber optic modems are installed, the modem power supply and battery backup shall be independent of the fire alarm system power supplies to allow for fire alarm panel servicing without network interruption.

18. The fire alarm system control panel shall not contain amplifiers or NAC circuits or SLC circuits or door controls. The building fire alarm control panel shall contain system control equipment only.

19. Fire alarm system programming shall not include timing functions for interfaced equipment. The fire alarm system shall not be used to sequence events such as time of day security, shunt trip delays, etc.

20. AHU shutdown relays shall be provided where air handler shutdown is required. The shutdown relay shall be controlled by either a supervised NAC circuit, independently controlled programmable supervised duct detector output circuit, or I/O point circuit. The shutdown relay shall not be controlled by an electronic control module. Each shutdown relay shall have two sets of form C contacts, the first set to be used for the shutdown signal and the second set used for notification to the building automation system. The shutdown relay shall be located adjacent to the controller for the AHU.

21. Where the building automation system requires signals in addition to the AHU shutdown signal, the additional signals shall be provided through a backnet interface.

22. Where the system design does not require a controlled output from a specific duct detector, a duct detector without the optional output circuit shall be installed.

23. System power supplies shall not be used for door holders. Provide stand-alone addressable NACs for door holder power and switching.

24. Stand-alone power supplies shall not be used to provide power for control panel equipment or cards including I/O cards and I/O output power.
25. Remote test stations shall not be installed on any system detector.

26. Smoke detectors shall be installed in all exit access corridors, electrical rooms, storage rooms, telecommunications rooms, shops, laboratories, and at all fire alarm equipment and control panel locations including NAC panel locations.

27. Corridor smoke detectors shall be installed within five feet of any cross corridor door on each side of the door.

28. Smoke detectors shall be installed within ten feet of any stairwell door where the stairwell has a stairwell pressurization fan.

29. Smoke detectors shall be installed within five feet on each side of any door requiring an interface with the fire alarm system.

30. Smoke detectors shall be installed and located as required for all auxiliary functions requiring smoke detection including but not limited to stairwell pressurization, elevator recall, door release, fire shutters, smoke damper control, plenum smoke return etc.

31. Building fire alarm system notification device shall be installed in MRI rooms in addition to any pre action notification device.

32. Where power operated doors are required to be interfaced with the building fire alarm system, dedicated smoke detectors, installed in accordance with “NFPA 72 detectors for door release” shall be used to initiate the signal for deactivation of the manual power open function. This signal is in addition to a general by floor alarm signal which signals the powered door operator to close the doors. Two separately programmable fire alarm system relays shall be required to provide this feature.

33. The fire alarm system shall automatically unlock all egress doors upon alarm detection as required by code allowing for immediate egress and stairwell reentry. Manual signaling for door release or stairwell reentry from a switch in the fire command center shall not be a function of the fire alarm system.

G. Record Documents

1. In addition to the manuals required elsewhere in the documents, prior to Substantial Completion, fire alarm systems Shop Drawings shall be upgraded to Record documents including labeling, program, and wiring details. One (1) set of reproducible masters and Drawings on a CD in a DXF format shall be provided to the Owner for their use.

2. Contractor shall provide a site specific list of service repair part numbers for all system components. Standard manufacturer’s service repair parts list is not acceptable. The part numbers provided shall be the only numbers needed to order correct replacement parts. All system components shall be identifiable by a permanent part number. The exact parts used on site shall be listed with the correct service part number. The site specific list shall include a cross reference from the component identification number to the correct replacement part order number.

3. All documents required by code and these specifications shall be included in the record documents. The record documents shall be available at the final acceptance test.

H. Disclaimers or Exclusions:
1. Contractor shall not submit disclaimers or exclusions which may result in a fire alarm system which is not complete, or a fire alarm system which is not fully operational, or a fire alarm system which is not compliant or a fire alarm system which does not comply with these specifications. Disclaimers which conflict with these specifications shall not be considered valid.

1.07 MATERIAL STORAGE

A. MD Anderson does not provide storage facilities except for onsite storage as directed by the project manager.

1. All contractor-provided equipment and components shall be new and packaged in unopened manufacturer’s packaging. Components in open packages or delivered loose to the jobsite shall be considered used and not acceptable for installation unless specifically approved by the Environmental Health and Safety department on a case by case basis.

2. Equipment, components, tools and materials shall be stored on the jobsite as directed by the project manager.

3. Equipment, tools, components and materials shall not be stored in mechanical rooms, or electrical rooms, or air chases, vacant rooms or any other location except the project site as directed by the project manager.

4. The contractor shall protect from damage all equipment stored on the project site.

5. All equipment and components stored on MD Anderson property by the contractor shall be for designated MD Anderson projects only. All equipment, materials, and component cartons shall be marked with the MD Anderson project number for which they are designated.

1.08 EXTRA MATERIALS

A. Refer to Section 01 78 46 for Maintenance Material Requirements.

1.

1.09 WARRANTY

A. Contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent defects for a period of one (1) year after system acceptance. The Owner shall determine the date of acceptance. The acceptance date shall not come before substantial completion of the system. The acceptance date shall not come before the system has been completely tested and certified. The acceptance date shall not come before written acceptance by the MD Anderson Cancer Center (MDACC) Environmental Health and Safety (EH&S) department.

B. The Owner reserves the right to make changes to the fire alarm system during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any such changes made by Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the fire alarm system. Any disagreement between Owner and Contractor on such matters shall be subject to resolution through the Contract ‘Disputes’ clause.

C. Contractor shall maintain an immediately available local stock of all replacement components necessary for emergency warranty repairs.
D. Contractor shall provide a site-specific list of service repair part numbers for system components. Standard manufacturer’s service repair parts list is not acceptable. The exact parts used on site shall be listed with the correct service repair part numbers.

E. Contractor shall provide written documentation of all warranty service to the Environmental Health and Safety office. Documentation shall include a description of repairs, any component replaced and the cause of any component failure.

F. Contractor shall maintain a record of warranty repairs on site. The specific location shall be the R2 2743 fire command room. Contractor shall provide a record for each warranty service call. The record maintained at this location shall include the time and date the warranty service was requested by MDACC, the time and date the onsite service was initiated, times and dates of any suspension of active corrections prior to the service problem being corrected and the reason for the suspension of service, the time and date of the final completion of the service, the name(s) of the responding technician(s), the exact reason of system or component failure. The building for which the service was provided shall have the appropriate service sticker attached to the control panel.

G. The equipment manufacturer shall make available to the Owner a maintenance Contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72 guidelines.

H. Repair service shall be provided 24 (twenty-four) hours per day. Request for routine service and/or repairs shall be responded to within six (6) hours. Emergency request for service and/or repairs shall be responded to within six (6) hours. The contractor shall arrive on site within six hours of a request for warranty service.

I. The responding technician shall be qualified to work on the warranted equipment and have all the tools and equipment necessary to repair the system, programming or components.

J. In the last month of the Warranty Period, all System software and firmware, software, drivers, etc. will be upgraded to the latest release (version) in effect at the end of the Warranty Period.

K. At any time during the Warranty Period that Contractor is on Site for maintenance, emergency, or normal service, Contractor shall notify Owner via MD Anderson Monitoring Services or directly to the fire safety supervisor. Contractor shall notify said personnel of all work anticipated being involved for the service work. In addition, no work affecting system operation shall commence until express permission is granted. After the work is completed a work order ticket describing in detail all work performed (i.e. hardware replaced or serviced, software or firmware modifications made, etc.), hours worked, follow-up work required, etc., must be signed by an authorized building manager. Service tickets shall include an explanation of the cause of any component failure. The warranty service record at R2.2743 must be updated with all required details of the service call.

PART 2 - PRODUCTS

2.01 GENERAL

A. System

1. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2. Each system shall include all components necessary to meet interface requirements with other systems identified in these specifications.
3. All panels and peripheral devices shall be the standard product of a single manufacturer.

4. Each system shall include all control center panels, transponders, manual pull stations, smoke detectors, heat detectors, speakers, strobe lights, horns, fire phones, wiring, outlet boxes, and all the necessary material for a complete operating system. The panels and peripheral devices shall be compatible with and interface via one of the existing fire alarm system networks.

5. The system shall have sufficient capacity to incorporate all equipment and perform all functions as stipulated within these Specifications and the Drawings for this Project.

6. The fire alarm system shall allow for loading or editing special instructions and operating sequences as required. The system shall be capable of onsite programming to accommodate and facilitate building parameter changes or changes as required by local codes.

B. Fire Alarm Control Panel

1. The Central Processing Unit (CPU) shall be compatible with the existing MDACC networked systems.

2. The alphanumeric display, keyboard and printer shall be operational on battery standby power.

3. Building control panels shall have the large expanded display.

4. Control panels shall be installed so that the readable portion of the panel display is not more than sixty six inches above the finished floor and not less than 60 inches above the finished floor.

5. The fire alarm control panel shall be equipped with all software, firmware, and hardware necessary to communicate to associated network nodes and receive audio voice messages from remote network locations over fiber optic connections. Listed fiber optic modems may be used to meet this requirement. The fire alarm contractor shall demonstrate this functionality at the time of the acceptance test.

6. The fire alarm system controls shall contain all custom message firmware, hardware and software necessary for the delivery of the MD Anderson custom voice messages including DR. Red announcements, drill announcements, all clear announcements and testing announcements. Actual messaging delivered upon alarm conditions shall be building specific and selectable on site. Voice messaging shall initiated by password protected switch inputs on the face of the voice control panel. Text for voice messages shall match that of Attachment "B".

7. The fire alarm system controls shall contain the custom MD Anderson multilevel test functions. The test functions include floor test, notification device test, AHU/damper test, door test, elevator test and sprinkler test. Selection of test features shall be by password protected switches on the main fire alarm control panel. Test features shall perform as outlined in Attachment "D".

8. Each fire alarm control panel, equipment cabinet, transponder cabinet, terminal cabinet, battery cabinet or fire phone cabinet, shall be identified with a plastic tag permanently affixed to the cabinet and engraved with 1 inch letters identifying the cabinet.
9. To accommodate and facilitate Project Site changes, notification appliance circuits shall be individually configurable on Site to provide selective alarm, general alarm; evacuation, alert, test or no alarm, supervised door release, fan, or damper control. All audio appliances installed shall have the capability to transmit voice messaging, i.e. speakers, but may be installed to transmit tones only where appropriate and when the MD Anderson EH&S department has authorized to do so in writing prior to bid approval.

10. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer’s name on each component.

C. Equipment Enclosures

1. The fire alarm control panel electronics shall be housed in a cabinet(s) of sufficient size to accommodate the specified equipment. The cabinets shall be equipped with locks and transparent door panel(s) which will prevent tampering and allow full view of the system controls.

2. Fire alarm equipment cabinets other than the main control panel shall be equipped with locks and a solid door to prevent tampering. All system cabinets shall be keyed alike.

D. Wiring

1. The system wiring shall consist of a communications network to interlink all transponders to the main system controls; and a multi-addressable peripherals network to interlink fire alarm devices to the transponders. The system shall use addressable peripheral devices communicating over digital communications circuits to minimize wiring and to maximize system expansion without the need to make an additional home run to the control panel. Each digital circuit shall not have more than 50 percent of its capacity used during initial installation so that space is available for future expansion.

2. All exposed fire alarm wiring installed above ceiling, on the surface of ceiling, in open raceways, on sidewalls or fished in concealed spaces shall be red in color. This applies to all fire alarm system circuits including but not limited to S.L.C. circuits, initiation circuits, notification circuits, control circuits, door holder circuits, fireman’s telephone circuits, auxiliary power circuits, hardwired network communication circuits and annunciator circuits. It is the intent of this specification that all exposed fire alarm system wiring is readily identifiable by color.

3. All data wiring serving peripheral devices shall be shielded style wire.

4. All speaker circuits shall be shielded style wire.

5. All telephone circuits shall be shielded style wire.

6. All wiring shields shall be free of grounds and the shield shall be continuous throughout the circuit.

7. Installation of wiring and peripherals shall be in accordance with recommendations of the manufacturer of the material being installed.

8. Where wiring is required to be run underground or in the slab, direct burial type cable shall be run in conduit. All wiring run underground or in slab shall be tested for insulation integrity and the results of the integrity test shall be recorded in the record documents.
9. Where wiring is required to be run underground or in the slab, the conduit shall be marked at each entry with the next remote exit location. System drawings shall clearly show each entrance to the slab or underground and note the corresponding exit.

10. Contractor shall furnish and install a drawing print hanger and brackets on the wall in the fire command room. The hanger shall have the capacity to accommodate a complete set of fire alarm system drawings thirty inches by forty inches. The top of the hanger brackets shall be installed at a height of fifty-two inches above the finished floor. This requirement applies to new fire command rooms or existing fire command rooms where no brackets or hangers are present.

11. The fire alarm control panels, the remote transponder cabinets, terminal cabinets and equipment cabinets shall be accessible for maintenance without special tools or ladders. Clearance around panel locations shall allow for the panel doors to be opened fully as designed by the equipment manufacturer. All fire alarm cabinets shall be keyed alike. All keys shall be delivered to the environmental health and safety representative at the time of the acceptance test. Back boxes shall be installed so that the readable portion of the panel display is not more than sixty six inches above the finished floor and not less than 60 inches above the finished floor.

12. A terminal cabinet shall be installed adjacent to each equipment cabinet. The terminal cabinet shall be keyed alike with the control panel. All field wiring serving the equipment cabinet including data circuits, notification circuits, and other data and power wires, shall be terminated in this panel and shall be permanently labeled. Writing on the wiring insulation with a marking pen as a method of labeling shall not be acceptable. Labels shall indicate the circuit number and the area served. This cabinet shall be accessible without special tools or ladders. Terminals in this cabinet will allow wiring to be disconnected for the servicing of individual circuits. Panel doors shall be a hinged door. Terminal cabinets and other fire alarm equipment shall be installed adjacent to, not above or below the equipment panels. Existing cabinets shall be expanded to provide sufficient terminals for any additional wiring added to the equipment cabinet. The terminal cabinet shall be used for wiring terminations only and shall not be used to house system components, relays, modules etc. The minimum size of any terminal cabinet shall be 24 inches by 24 inches and the cabinet shall be of sufficient size to allow for the expedient disconnection of an individual circuit without interruption of any other circuit. All terminals used shall be securely mounted to the backplane of the terminal cabinet. A minimum of 30 percent unused terminal capacity shall be provided in the terminal can. A 24 inch by 24 inch terminal cabinet shall have a minimum of six inches of clearance between the conduit entrance at the top of the cabinet and the top of the terminal strip to allow for wire routing. Where conduits enter at the sides or bottom of the cabinets additional six inches of clearance shall be provided at these locations. Where terminal cabinet size increases the clearances required shall also increase at a ratio of three inches additional clearance for each additional twelve inches of cabinet size.

E. Remote Dialers

1. Wherever a fire alarm control panel is installed in a building which cannot be served by the fire alarm network communications loop the following equipment shall be provided for alternate reporting to both the Monitoring Services Control Room, Main Campus and Knight Road locations:
a. An automatic telephone communicator shall be provided to facilitate remote reporting. The communicator shall be a Silent Knight Model 5104 fire control communicator. The dialer shall be installed in the fire command room or in the telephone communications room if no fire command room is present. The dialer shall be programmed to report primarily to the receiver in Monitoring Services and to the receiver at the Knight Road location.

b. Three (3) relays shall be provided at the dialer location, one (1) to activate upon alarm, one (1) to activate upon a system trouble condition and one (1) to activate upon a supervisory condition. The relays shall be permanently labeled as to their function. The relays shall be controlled from the fire alarm control panel and connected to the panel via supervised signaling circuits. Wherever relays are used the relay shall include an LED indicator which indicates the activated state of the relay. The LED indicator shall allow for visual verification of relay activation without disassembly of the relay or the relay enclosure.

c. The dialer shall be connected to the public switched telephone network upstream of any private telephone system at the protected premises. Two (2) telephone lines, a primary line and a secondary line, shall be provided for the dialer. The telephone lines shall be terminated at the dialer location using RJ31X style jacks.

2.02 MANUFACTURERS

A. Simplex.

B. Edwards Systems Technology (EST).

C. Silent Knight Model 5104 fire control communicator (dialer).

D. Acceptable Substitutions:

1. Wherever a specific vendor’s name, type and model number is given and the option of an acceptable solution is specifically stated, all substitutions submitted by the Contractor shall be approved in writing by the MD Anderson EH&S department. Any fire alarm CPU installed must be either EST or Simplex brand in order to maintain complete functionality of each network. Any auto dialer installed must be the Silent Knight model designated in these specifications.

2. The fire alarm system installed shall interface and transmit comprehensive data and control signals beyond alarm, trouble and supervisory signals with the existing Simplex or EST network. There shall only be no more than (2) different brands of fire alarm networks in total at MD Anderson.

3. Where renovations occur in a building, the entire alarm system for that building shall be of one manufacturer and must fully integrate with either the existing Simplex network (i.e. be a Simplex brand system) or EST network.

2.03 OPERATION

A. Fire Alarm Control System Network:

1. Each Fire Alarm Control Panel shall operate as a proprietary local system.

2. Each fire control panel, voice control panel or network node shall be equipped with a display panel. CPUs shall not be installed without a display panel.
3. The building Fire Alarm Control Panel shall have an expanded display.

4. Under normal condition the front panel shall display the current time and date.

5. Note requirements for remote annunciation at both central monitoring stations (Main Campus monitoring services and Knight Road UTPD locations) and at the R2.2743 and B1.4351 locations.

6. The panel shall display the following information relative to the abnormal condition of a point in the system:
   a. Custom location label (40 Character minimum).
   b. Mnemonic identifier or associated nametag.
   c. Point status (i.e., alarm, trouble).
   d. Priority banner (Fire, Security).

B. The Fire Alarm Control Panel shall have a printer and shall print the following information relative to the abnormal condition of a point in the system:
   1. Custom location label (40 Character minimum).
   2. Mnemonic identifier or associated nametag.
   3. Point status (i.e., alarm, trouble).
   4. Priority banner (Fire, Security).

C. Systems not capable of such a printer on the fire alarm control panel faceplate shall include a printer meeting the above requirements and battery backup for printer. The printer shall be located at the fire alarm control panel location.

D. Fire alarm control panels shall include a fire drill, test and inspection program. The manufacturer shall provide a two-step test program that shall be incorporated into each system to allow for fire drills, annual tests, and inspections. The program shall function uniformly with the existing programs now in use by the Owner (further detail will be supplied to the Contractor upon request). Should the test feature be on for an inappropriate amount of time (manually adjustable), the program shall automatically print out a trouble alarm, which will require operator acknowledgment every thirty (30) minutes until the system is restored to normal operation. The test program shall include a by floor test function as the first stage and switch selected notification, AHU, door, elevator and sprinkler test functions as the second stage. Test features shall perform as outlined in Attachment “D”.

E. Fire alarm control panels shall include a network disconnect function to allow for testing and maintenance without disruption to the overall network. The fire alarm control panel shall include a network bypass function which isolates that system and that system’s associated nodes from its network and closes the network loop as a single function. The network disconnect function shall be initiated by a password protected switch at the control panel location. The disconnected system shall continue to function as a complete building system without interruption between that building system’s nodes. The network shall continue to function normally except that a node missing trouble shall be displayed for each disconnected node.
2.04 ALARM SEQUENCE

A. Fire Alarm Detection and Control: System alarm operation for any manual or automatic fire alarm initiating device activation shall be as follows:

1. The “PRIORITY 1 ALARM” LED shall flash on the fire alarm control panel in the building Fire Command Room and at the Monitoring Services Control Room, the UTPD monitoring station and at the R2.2743 and B1.4351 locations until the alarm has been manually acknowledged. When the alarm has been acknowledged, this same LED shall latch on. A subsequent alarm received after any acknowledgment shall again flash the same LED.

2. The source of alarm shall be annunciuated via an English language description on the alphanumeric display at the fire alarm control panel in the following locations:
   a. Fire Command Room
   b. Monitoring Services Control Room
   c. UTPD Monitoring Station
   d. Room R2.2743
   e. Room B1.4351

3. All alphanumeric device labels shall follow the standard MD Anderson label format and are subject to the approval of the Environmental Health and Safety representative. Any labels not approved by Environmental Health and Safety prior to installation are subject to reprogramming at the contractors expense. Label format shall be as shown in Attachment “C”.

4. All fire speakers and all fire strobe lamps on the floor of alarm, the floor below and the floor above shall be activated.

5. All door holders, fire shutters and automatic smoke dampers shall be released on the floor of the alarm.

6. Where communicating spaces connect multiple floors, all connected floors shall be considered the floor of alarm for sequencing purposes.

7. Where door release on multiple floors is required due to communicating spaces, the doors shall be programmed to release from the affected floors and not from a general alarm condition.

8. Doors in exit passageways or stairwell doors shall close upon general alarm initiated from any initiating device.

9. All alarm conditions shall be visually indicated at the system control panel and at the Monitoring Services Control Room, the UTPD monitoring station, and at the R2.2743 and B1.4351 locations.
10. In addition to network annunciation requirements, all Fire Alarm Control Panel alarm trouble and supervisory signals shall be annunciated at the backup annunciator at the Monitoring Services Control Room. This backup annunciator will sound the general campus alarm and trouble chime and flash the general campus alarm and trouble strobe unit. All fire alarm control panels must interface with this unit to facilitate the general campus alarm signal and local acknowledge. Contractor shall provide all modems, hardware, control equipment and interface equipment to make this interface fully functional.

11. All alarms shall be recorded with the time and date on the fire alarm control panel printer at the building Fire Command Room.

12. The alarm activation of any two elevator lobby smoke sensors in an elevator lobby shall, in addition to the operations listed above, initiate a signal to the elevator controls to cause the elevators to be recalled to their primary or alternate level dependent on the origin of alarm.

13. Alarm verification feature shall not be active at the time of installation. Alarm verification operation shall be only for smoke sensor alarms designated by the Environmental Health and Safety Department. All other sources of alarm shall be processed immediately. The alarm confirmation or verification feature shall not be used on any detector which has a dedicated control function such as duct detectors, door release detectors or detectors used for elevator recall.

14. The system operation shall be such that the alarm operation of any alarm-initiating device shall not prevent the subsequent alarm operation of any other initiating device due to wiring or power limitations.

15. The act of turning any sprinkler valve wheel shall initiate a distinctive pulsing signal and cause the supervisory LED to flash at the system controls so that there shall be no confusion between valve activation and opens and/or grounds on fire alarm initiation wiring.

16. All operation subsequent to automatic or manual activation’s of all system functions shall occur within a maximum time of ten (10) seconds regardless of system size.

B. Manual Voice Paging Sequence:

1. The System shall be configured to allow selective voice paging.

2. If any speaker manual control switches are activated, the control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers. When manually selecting speakers for voice paging, evacuation or supervisory tones shall not be delivered to the selected speakers.

3. Facility for total building evacuation and paging shall be provided to allow for activation of speakers. This shall be accomplished by means of an “All Circuit” switch.

4. Each voice control panel will be equipped with the MD Anderson custom firmware containing custom voice messages for all clear, drill and testing announcements. Voice messages shall be activated via switch controls. Custom message text is found in Attachment “B”.
5. Each voice control panel shall be designed to receive audio voice and system control signals from the audio system at the Main Campus location R2.2743 and retransmit the signals to selected floors in the building served by the voice control panel. Controls of this operation shall be initiated from the R2.2743 and Monitoring Services locations. All equipment and software needed to make this function operational shall be installed prior to the final acceptance test. No additional hardware, software, firmware, interface equipment, modems or fiber connections shall be needed to make this function fully operational.

6. Emergency voice/alarm communications shall reproduce prerecorded, synthesized or live messages WITH VOICE INTELLIGIBILITY in the occupied area, this being achieved when the quantity Iav-s exceeds a Common Intelligibility Scale (CIS) score of 0.70 or better, as specified in B3 of IEC 60849, Sound Systems for Emergency Purposes, second edition. Preliminary test reports shall include documentation of voice intelligibility.

C. Two-way Voice Communication Sequence:

1. The system shall incorporate a Two-Way Firefighter Communication operation. Voice communications shall be clear with no interference. All fire phone locations shall be connected (via the transponders and multiplexed communication circuits) to the master phone at the fire alarm control panel. The operation shall be as follows:

2. The act of plugging a handset into an emergency phone jack or removal of any phone from its normal hook position shall cause the appropriate phone location LED to flash and a distinctive audible device to sound at the control panel. The subsequent picking up of the master phone and acknowledgment of the proper phone circuit shall silence the pulsing tone and cause the phone location LED to stop flashing and remain on. This action shall couple the remote phone to the master phone to provide direct and private communications. Normal operation of the firefighter phone controls shall not cause system trouble conditions.

3. Attempting to use a subsequent phone on the same circuit shall not cause the pulsing tone to activate if any two-way communications are already established. Any new circuits activated shall cause their discrete phone circuit LEDs to flash until acknowledged.

4. The Two-Way Communications System shall provide the capacity to handle simultaneous use of five (5) remote phones.

5. The act of unplugging all handsets in use and replacement of all remote phones to their normal hook position and returning all the related circuit acknowledgment switches to the normal position shall cause the restoration of all normal supervisory functions. If any remote phone is not hung up, or unplugged then the appropriate phone zone indicator LED shall flash and the pulsing tone shall resume at the control panel.

6. Phone operations (with the exceptions of phone system trouble) shall not be recorded on the system printer. However, it shall be possible to print this operation if required.

7. The system shall be configured to allow for remote paging from any firefighter remote phone location via the system speakers as manually selected at the main controls.

8. The phone system shall be free of background or induced noise.

D. Elevator Recall:
1. When appropriate alarms are reported, control points tied to the elevator control circuitry will energize and the elevators will be recalled to the primary floor for fire fighter’s use. If the initiating device is on the primary floor, the elevators will be sent to the predestinated alternate floor.

2. The Contractor shall provide all necessary cables and wire for elevator recall, including wiring to elevator car.

3. The Contractor shall install the elevator recall, alternate recall and elevator signal relays adjacent to the elevator wire gutter in the respective elevator machine room.

4. A minimum of two (2) smoke detectors in the same elevator lobby shall be required to initiate elevator recall.

5. Two lobby smoke detectors shall be located on the ceiling within 21 feet of the centerline of all doors within the elevator bank under control of the detectors.

E. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch is to be as follows:

1. Selected speaker circuits shall sound a selected tone and silenced by the alarm silence switch at the control panel or at the building Fire Command Room.

2. Selected visual alarm indicating appliances shall flash continuously until the fire alarm system is reset.

2.05 SYSTEM CONTROLS

A. Fire Alarm Control Panel

1. The Central Processing Unit, CPU, shall be compatible with the existing MD Anderson networked systems.

2. The alphanumeric display, keyboard and printer shall be operational on battery standby, as well as all power supplies, transformers, circuit boards, input-output connections, and batteries to meet all system requirements.

3. Each control panel shall have a liquid crystal display that shall be backlit for enhanced readability. It shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity. The building fire alarm control panel shall have the expanded large display. Control panels shall be installed so that the readable portion of the panel display is not more than sixty six inches above the finished floor and not less than 60 inches above the finished floor.

4. Should a trouble condition be present within the system and the audible trouble signal silenced, the trouble signal shall resound at preprogrammed time intervals to act as a reminder that the fire alarm system is not 100 percent operational.

5. Both the time interval and the trouble reminder signal shall be programmable to suit the Owner’s application.
6. The fire alarm control panel shall be equipped with all software, firmware and hardware necessary to communicate to associated network nodes, and receive audio voice messages from remote network locations over fiber optic cable connections. Multiple signal fiber optic modems may be used to meet this requirement. The fire alarm Contractor shall demonstrate this functionality at the time of the acceptance test. Wherever fiber optic modems are used the modem power supply and battery backup shall be independent from the fire alarm panel power supply to allow for uninterrupted communication between modems during panel servicing.

7. The fire alarm control panel shall not be used as a system equipment panel. The fire alarm control panel shall be a separate cabinet containing building controls only. Field detection, notification and control circuits shall not be routed to the fire alarm control panel, except when the fire alarm control panel is the only panel containing the buildings fire alarm systems electronic controls and the wiring method has been authorized in writing by the Environmental Health and Safety Department.

B. Equipment Panels

1. Where shown on the Drawings and where appropriate, provide and install a remote equipment panels compatible with existing building control system. Construction shall be modular with solid state, microprocessor based electronics.

2. Fire alarm equipment panels shall not be located in the fire command room.

3. Primary Keys and Panel Display: Each equipment panel or node containing its own CPU shall have a liquid crystal display that shall be backlit for enhanced readability. It shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity.

4. With LCD display, an operator at the equipment panel having a proper access level, shall have the capability to manually control the following for each analog sensor:
   a. Examine equipment and point status.
   b. Examine history log.

5. Equipment panels shall be installed so that the readable portion of the panel display is not more than sixty six inches above the finished floor and not less than 60 inches above the finished floor.

6. NAC panels shall be installed so that the top of any NAC cabinet is less than seventy inches above the finished floor and the bottom of any NAC cabinet is at least thirty six inches above the finished floor.

C. Equipment Enclosures

1. The fire alarm control panel shall be housed in a cabinet(s) of sufficient size to accommodate the aforementioned equipment. The cabinet(s) shall be equipped with locks and transparent door panel(s) providing freedom from tampering yet allowing full view of the various lights and controls.
2. Fire alarm equipment cabinets shall be housed in a cabinet(s) of sufficient size to accommodate the aforementioned equipment. The cabinet(s) shall be equipped with locks and solid door panel(s) to prevent tampering. Transponder cabinets shall be keyed alike with the fire alarm control panel. Cabinet doors shall open fully and not obstruct access to other control panels or equipment cabinets or terminal cabinets.

D. Batteries

1. Wherever a control panel, transponder, NAC panel or other panel requires batteries as a secondary source of power, the batteries shall be permanently marked with the date of manufacture. The date of manufacture shall be written in the Standard English date format.

2. Only manufacture date codes which are decipherable without a separate table or legend may be used for this purpose. The contractor may decipher the manufacture date from a code and permanently mark the date in the English format. The manufacture date shall be clearly identifiable as the date of manufacture.

3. The batteries installed shall not be older than one year from the date of manufacture.

4. The date of installation shall also be permanently marked on the batteries. The installation date shall be clearly identifiable as the installation date.

2.06 REMOTE ANNUNCIATOR(S)

A. System Annunciators.

1. Provide annunciators capable of two methods of acknowledgement for each abnormal condition. Method choice shall be field programmable.

2. For NFPA 72 Chapter 9 requirements: pressing the appropriate acknowledge button shall display and acknowledge the first unacknowledged condition in the list. Each unacknowledged condition in the list must be acknowledged individually.

3. For NFPA 72 Chapter 6, 7 or 8 requirements: pressing the appropriate acknowledge button shall globally acknowledge all unacknowledged conditions in the list.

B. Nurse Station Annunciators.

1. Wherever patient room smoke detectors are required to be annunciated at the nurse’s station the annunciator shall be a peripheral of the fire alarm system. Annunciation of patient room smoke detectors through other systems such as nurse call systems is not acceptable.

2. Nurse station annunciators shall be programmable to annunciate only the alarms from rooms required to be monitored from that nurse’s station.

2.07 PERIPHERAL DEVICES

A. General:

1. Where peripheral devices are installed outside, in wet locations or in cold rooms the devices and mounting boxes shall be the waterproof type.

B. Speakers:
1. The moisture-repellent, fire-retardant speakers shall be selectable for 25-volt circuits or 70-volt circuits.

2. The speaker shall be equipped with a matching transformer with multiple taps (0.25W, 0.5W, 1W and 2W).

3. The speaker shall have a minimum sound level of 75 db at 10 feet and a maximum of 88 db at 10 feet.

4. Speakers shall be red in color except where white is used to match existing devices.

5. The speaker shall allow surface/or-flush mounting capabilities. Where surface mounted speakers are installed a skirt enclosure shall be installed to conceal the electrical box to which the speaker is mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall.

6. Speakers shall be wall mounted at a height of 83 inches to the center of device.

7. Contractor to ensure speakers have the correct sound pressure as per NFPA 72.

8. Ceiling mounted speakers shall not be acceptable except where a hard ceiling exists and upon approval from the Environmental and Health and Safety representative. Speakers mounted in ceiling tiles shall not be acceptable. Speaker shall be UL listed for its intended purpose.

C. Strobe Light:

1. ADA Visual notification appliances shall be comprised of a Xenon flashtube with a clear lens and be entirely solid state.

2. Visual notification devices shall be red with white lettering except where white is used to match existing devices.

3. Visual notification devices shall be selectable for either free run or synchronized operation.

4. Visual notification devices shall have selectable candela levels.

5. These devices shall be UL 1971 Listed and shall be wall mounted.

6. Provide a unit approved for ADA compliance,

7. The lexan lens shall be pyramidal in shape to allow better visibility.

8. Where surface mounted strobe lights are installed a skirt enclosure shall be installed to conceal the electrical box to which the strobe lights are mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall.

9. Ceiling mounted strobe lights shall not be acceptable except where a hard ceiling exists and upon approval from the Environmental and Health and Safety representative. Strobe lights mounted in ceiling tiles shall not be acceptable.

10. Strobe light candela shall comply with NFPA Standards based on room size and device location.

11. Install units at 83 inches height from finished floor to bottom of lens.
12. Where existing visual units are installed at a code compliant height above floor, the new strobe unit may be installed at the same compliant height to avoid an uneven appearance.

13. The installing contractor shall coordinate between trades to ensure that placement of cabinets, shelving, or other material does not interfere with occupant’s view of the strobe device.

14. Strobe lights shall not be added to existing signal circuits without first performing the necessary calculations to ensure adequate power is available to both the circuit to which the device is to be added and the fire alarm control panel power supply which supplies the power to the circuit. These readings and written calculations shall be documented in the equipment submittal and forwarded to the MD Anderson EH&S department via the Owner’s Project Manager. Existing power supply loads must be determined when adding additional equipment.

D. Speaker/Visible Alarm Notification Appliances:

1. Audible/Visible devices shall conform to MD Anderson Standards and shall provide a common enclosure for the fire alarm audible and visual alarm devices.

2. The unit shall be complete with a tamper resistant, pyramidal shaped Lexan lens with Fire lettering visible from a 180-degree field of view.

3. Provide a unit approved for ADA compliance. The moisture-repellent, fire-retardant speakers shall be selectable for 25-volt circuits or 70-volt circuits.

4. The speaker shall be equipped with a matching transformer with multiple taps (0.25W, 0.5W, 1W and 2W).

5. Visual portion shall have selectable candela levels.

6. Visual portion shall be selectable for free run or synchronized operation.

7. Unit shall be complete with all mounting hardware.

8. Where surface mounted Audible/Visible devices are installed a skirt enclosure shall be installed to conceal the electrical box to which the Audible/Visible device is mounted. The correct surface box shall be used to ensure the skirt fits properly and is flush with the wall.

9. Audio/visual unit shall be UL Listed for its intended purpose.

10. Audio visual devices shall be red in color except where white is used to match existing devices.

11. Install units at 83 inches height from finished floor to bottom of lens.

12. Where existing visual units are installed at a code compliant height above floor, the new strobe unit may be installed at the same compliant height to avoid an uneven appearance.

E. Relays, electronic control relays, and electronic control modules programmed as relays:
1. Wherever relays or electronic control modules are used to interface with control functions, the relay or electronic control module shall include a red LED indicator which indicates the activated state of the relay or electronic control module. The red LED indicator shall remain steadily lit while the relay or module is activated. If necessary to provide this visual indication of relay activation, a second relay and 24 volts supervised control power may be required in addition to the module relay. The red LED indicator shall allow for visual verification of relay or electronic control module activation without disassembly of the relay or electronic control module enclosure.

2. The red LED indicator shall light steady as long as the relay or electronic control module is activated.

3. Relays shall be normally in the non-operated mode and shall activate upon alarm.

4. All relays shall be mounted adjacent to the interfaced equipment except where the relay is used to switch power to multiple devices it shall be mounted adjacent to the power source.

5. Relays and relay indicators shall be labeled with the relay’s function, controlled unit number and circuit number. Labels shall be uniform, printed, and clearly legible from floor.

6. Where the relay is mounted above five feet or the relay's LED cannot be observed from floor level or without lifting ceiling tiles a remote indicator shall be installed.

7. Relay cover and base shall be marked to ensure the correctly labeled cover remains with the correct base.

8. The fire alarm Contractor shall coordinate with other trades to ensure the relay used is the correct contact ampere rating for the switched current.

F. Water Flow Switches:

1. To prevent false alarms, the flow switch shall incorporate an adjustable time delay mechanism between the paddle-operated stem and the alarm initiating contacts. The time delay shall be adjusted to provide a delay time between 30 to 45 seconds from the initiation of water flow.

2. A tapped ½ inch conduit connection shall be provided.

3. Flow switch shall be UL Listed for its intended purpose; furnished mounted and adjusted under Division 23 and connected under Division 26.

G. Sprinkler Valve Tamper Switches:

1. Sprinkler valve tamper switches shall be provided with either two sets of single pole, double throw (SPDT) switches as required.

2. A tapped ½ inch conduit connection shall be provided.

3. Tamper switch shall be UL Listed for its intended-purpose; furnished mounted and adjusted under Division 23 and connected by Division 26.

H. Door Holders:
1. Combination door closers / door holders shall not be specified as a component of the fire alarm system. Where such combination devices are provided the devices shall be independent from the fire alarm system and shall not be powered from any fire alarm system source. The fire alarm system shall provide a relay for door release signaling purposes only.

2. Magnetic door holder back boxes shall be mounted to building structure.

3. Retrofit boxes or other boxes mounted to sheetrock only shall not be acceptable.

4. Magnetic door holders shall be UL-Listed for their intended purpose.

5. Coordinate mounting with door hardware

6. Magnetic door holders shall have an approximate holding force of 35 lbs.

7. The door portion shall have a stainless steel pivotal mounted armature with shock absorbing nylon bearing.

8. Unit shall be surface, flush, semi-flush or floor mounted as required.

9. Magnetic door holders shall be 24 volts D.C.

10. System power supplies shall not be used as a source for door holder power.

11. Magnetic door holders shall be powered from a NAC power supply at a designated remote location(s). The NAC power supply shall be dedicated to door holder operation. The dedicated power supplies shall not share power with notification devices. The dedicated NAC aux power output shall not be used for door holders or for powering fire alarm peripherals or devices.

12. Magnetic door holder operation shall be independent from another operation such as damper or fire shutter control.

13. The door holder circuits shall be individually wired to and switched from the designated NAC panel. Auxiliary relays at the NAC panel may be used to provide the switching function.

14. When magnetic door holders are added to an existing system the submittal shall include a power availability analysis showing the intended source of power, the door holder circuit capacity and standby power capacity.

15. Coordinate mounting with door hardware.

16. Automatic Door / fire alarm system interface relays shall be switched from a dedicated door holder NAC.

17. A conceptual drawing of a door control NAC is provided as attachment “F”.

2.08 ADDRESSABLE PERIPHERAL DEVICES

A. General:

1. The system control panel, over its peripheral data circuits, must be capable of communicating with the types of addressable devices specified below.
B. Addressable Pull Stations:

1. Addressable pull stations shall contain electronics that communicate the station status (alarm, normal) to the control panel over two (2) wires, which also provide power to the pull station. The address shall be set on each station. The stations shall be manufactured from high impact red lexan. Lettering shall be raised and painted white. The station shall mechanically latch upon operation and remain so until manually reset by opening with a key.

2. Pull stations shall be dual action.

3. The addressable manual station shall be capable of field programming of its address location on an addressable signaling line circuit.

4. There shall be no limit to the number of stations, detectors, or addressable monitor modules which may be activated or in alarm simultaneously.

5. The operable part of the manual station shall be installed 48 inches above finished floor.

6. At any outside location and any location subject to moisture, weatherproof manual stations shall be installed.

7. Pull station break rods shall be installed at the time of the acceptance test.

8. The keys for each pull station shall be delivered to the environmental health and safety representative at the time of the acceptance test.

9. For any project requiring more than 20 pull stations, two (2) stopper II type pull station covers shall be provided to the Owner as spare parts.

C. Photoelectric Smoke Detectors:

1. Smoke sensors and bases shall be listed to UL Standard 268 and documented compatible with the control equipment to which they are connected. The sensors shall be listed for both ceiling and wall mount applications.

2. The sensor shall be of the solid-state photoelectric type and shall contain no radioactive material. Sensor will use a pulsed infrared LED light source and be sealed against rear airflow entry.

3. The photoelectric type sensor shall be a plug-in unit that mounts to a twist-lock base.

4. The sensor shall fit into a base that is common with both the heat sensor and smoke sensor and shall be compatible with other addressable detectors, addressable manual stations, and addressable monitor modules on the same circuit.

5. There shall be no limit to the number of sensors, stations or addressable monitor modules that may be activated or in alarm simultaneously.

6. The photoelectric sensor shall have a fine 30 mesh or finer insect screen.

7. The sensor electronics shall be completely shielded to protect against false alarms from EMI and RFI (Electromagnetic and Radio Frequency Interference).
8. The detector shall be able to be disassembled in order to readily clean the smoke detection chamber. Manufacturer's cleaning instructions shall be provided for each type of detector used.

9. Smoke detector relay outputs shall not be used to control life safety functions.

10. Smoke detector alarm verification feature shall not be initially enabled.

D. Thermal Heat Detectors:

1. The thermal type sensor shall be a plug-in unit that mounts to a twist-lock base.

2. The sensor shall be a combination rate of rise/fixed temperature sensor U.L. Listed as a rate compensated heat detector.

3. The sensor shall fit into a base that is common with both smoke and heat sensors and shall be compatible with other addressable detectors, addressable manual stations and addressable monitor modules on the same circuit.

4. There shall be no limit to the amount of sensors, stations or addressable monitor modules, which may be activated or in alarm simultaneously.

5. Each sensor is capable of operating at a selectable rate of rise operation of 15 or 20 degrees F per minute and is self-restorable.

6. Each sensor is capable of fixed temperature operation selectable for either 117 or 135 degrees F, independent of the rate of rise setting.

7. Each sensor can be configured for utility monitoring and capable of sensing temperature between 32 and 158 degrees F.

E. Photoelectric Duct Detectors:

1. The sensor shall be photoelectric type that obtains its operating power from the current in the fire alarm detection loop.

2. Sensors shall be of the solid-state photoelectric type and shall operate on the light scattering, photodiode principle. To minimize nuisance alarms, detectors shall have a minimum 30 mesh insect screen and be designed to ignore invisible particles or smoke densities that are below the factory set point. No radioactive material shall be used.

3. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.

4. The duct detector may include a relay or relay driver output where a specific control function is called for. Wherever relays or electronic control modules are used to interface with control functions the relay or electronic control module shall include a red LED indicator which indicates the activated state of the relay. The red LED indicator shall light steady while the relay or electronic control module is activated. The red LED indicator shall allow for visual verification of relay activation without disassembly of the relay or the relay enclosure.

5. Where no specific control function is required, a duct detector without the output circuit shall be installed.
6. Activation of relays shall be performed through the system program. Tracking the alarm only condition of the duct sensor is not acceptable.

7. Each sensor shall be scanned by the control panel for its type identification to prevent inadvertent substitution of another sensor type. The control panel shall operate with the installed device but shall initiate a “Wrong Device” trouble condition until the proper type is installed or the programmed sensor type is changed.

8. The sensor electronics shall be immune from false alarms caused by EMI and RFI.

9. Where a duct sensor is located above the ceiling or wherever the alarm indicating red LED cannot be seen from the floor a remote alarm indicating red LED shall be provided. The red LED shall glow steady while the detector is in alarm. Remote LED alarm indicators shall be wall mounted except where a hard ceiling exists. Remote alarm indicators mounted in ceiling tiles shall not be acceptable. Where a relay output for specific control function is called for the remote alarm indicator is in addition to a relay activation indicator.

10. Where duct detectors are mounted in weatherproof enclosures, a remote alarm indicator shall be installed adjacent to the housing to allow for alarm verification without opening the housing. The weatherproof enclosure shall not be modified except for connecting conduit to the factory provided knock-outs. Enclosure “ears” shall be used for mounting. In no case are holes to be drilled in weatherproof enclosures for equipment mounting. Where a relay output for specific control function is called for the remote alarm indicator is in addition to a relay activation indicator.

F. Addressable Sensor Bases (where applicable):

1. Sensor bases shall be compatible with all models of the manufacturer’s sensors currently installed within the MD Anderson Campus.

2. If a wrong device type is installed the panel will continue to monitor for alarms and troubles using the default setting for the wrong device until the proper type is installed or the program is changed.

3. Each sensor base shall contain a LED that will flash each time it is scanned by the control panel.

4. Each sensor base shall contain a LED that will glow steady while the detector is in alarm.

5. Each sensor base shall contain a LED that will glow steady while the detector is in trouble. The trouble indicator(s) will extinguish during system fire alarm conditions.

6. The remote LED output of the sensor base shall not be used for control activation or relay functions.

7. Sensor Base Relay. Where sensor bases control dedicated relays, the relays shall be controlled by system programming. The operation of the relay shall not be directly dependent upon the alarm state of the detector. Relays may be used for signaling only. Other systems shall provide any secondary power necessary for the desired action. Other systems shall provide additional relays or contactors necessary for adequate switching capacity. Relay operation shall comply with other sections of these specifications. Sensor base relays shall not be used to initiate life safety functions.

G. Addressable Monitor Module:
1. Modules shall be used for monitoring of water flow, valve tamper, non-addressable detectors and AHU status.

2. An addressable interface module shall be provided for interfacing normally open direct contact devices to an addressable signaling line circuit.

3. Addressable monitor modules shall be capable of mounting in a standard electric outlet box. Module enclosures shall have cover plates to allow surface or flush mounting. Modules shall include all mounting hardware to allow for the removal of the modules cover while the module remains secure in the electrical box.

4. The module’s system address, function and device monitored shall be marked on the outside of the cover plate.

5. For conventional contact device monitoring with Style B or Style A (NFPA 72 initiating device circuit) wiring supervision. This type of addressable device module will provide power to monitor the status of a zone consisting of conventional 2-wire smoke detectors and/or N/O contact devices. The supervision of the initiating device circuit wiring will be Style B. These monitor modules will communicate the zone status (normal, alarm, trouble) to the control panel.

6. Addressable monitor modules shall include all mounting hardware to allow for the removal of the modules cover while the module remains secure in the electrical box.

7. Where addressable monitor modules are used to monitor sprinkler tamper and flow switches, separate modules shall be used for each function. Combination circuits such as WSO style shall not be acceptable.

H. Electronic Control Module

1. Electronic control modules will communicate the supervised wiring status (normal, trouble) to the fire alarm control panel and will receive a command to transfer the relay from the fire alarm control panel.

2. Electronic control modules shall not be used to control automatic doors, magnetic door release, smoke damper control, fire/smoke damper control, fire shutter control, smoke control signaling.

3. Wherever relays or electronic control modules are used to interface with control functions the relay or electronic control module shall include a red LED indicator which indicates the activated state of the relay. The red LED indicator shall glow steadily to allow for visual verification of activation without disassembly of the relay, electronic control module or their enclosures. Where the relay or electronic control module’s LED cannot be observed without lifting ceiling tiles a remote indicator shall be installed. The remote indicator shall be wall mounted except where a hard ceiling is available. Remote indicators mounted in ceiling tiles shall not be acceptable. The red LED shall remain steadily lit while the relay or electronic control module is activated. In order to provide the steadily lit red LED visual indication of relay activation of the electronic control module, a second relay and 24 volts supervised control power may be required in addition to the electronic control module relay. The control module’s red led indicator shall not illuminate when the module is not activated.
4. The electronic control module shall be supervised and uniquely identified by the control panel. Device identification shall be transmitted to the control panel for processing according to the program instructions. Should the module become non-operational, tampered with, or removed, a discrete trouble signal, unique to the device, shall be transmitted to, and annunciated at, the control panel.

5. All electronic control modules shall be labeled on the outside of the cover as to data circuit and device number, function and unit served.

6. Addressable electronic control modules shall be capable of mounting in a standard electric outlet box. Addressable monitor module shall include cover plates to allow surface or flush mounting.

7. Addressable electronic control modules shall include all mounting hardware to allow for the removal of the modules cover while the module remains secure in the electrical box.

8. High voltage circuits shall not be present in the electronic control module’s enclosure.

2.09 FIREIGHTERS TELEPHONE SYSTEM

A. General:

1. Provide a two way telephone system in compliance with NFPA 72.

B. Emergency Phone Jacks:

1. Provide Emergency Phone Jacks as shown on the Drawings. Each jack shall be mounted on a stainless steel single gang plate with the words “Fire Emergency Phone” screened on each.

2. Provide Emergency Phone Jacks for installation in each elevator car by the elevator Contractor. It shall be the responsibility of the fire alarm Subcontractor to ensure that the required wiring from elevator controls to each elevator car be installed by the elevator Subcontractor. Wiring to be provided by fire alarm Subcontractor.

3. Provide an emergency phone jack adjacent to the fire pump controller cabinet.

C. Emergency Phone Stations:

1. Provide Remote Phones in cabinets for installation in the building emergency control stations. The phone stations shall be keyed alike with the fire alarm system control panel.

2. Emergency phones shall be red and shall be equipped with an armored cable.

3. Provide Emergency Phone jacks for installation in each elevator car by the elevator Subcontractor. Wiring to the elevator cars will provide for the proper supervision of the phone station circuit. T-tapped wiring between cars shall not be acceptable.

4. Provide a minimum of five (5) Pluggable Emergency Phones within a storage cabinet to be mounted at the building Fire Command Room. The emergency phone cabinet shall be keyed alike with the fire alarm system control panel.

2.10 FACP REMOTE REPORT

A. Remote Devices:
1. The fire alarm control panel shall report to all existing remote annunciators on the fire alarm system's network. Where no network exists or a new network is installed or a network is expanded, or a network is modified, the network shall include new annunciators at all the existing campus annunciator locations.

2. At a minimum the fire alarm control panel shall report to remote locations at room R2.2743, the Monitoring Services Control room, room B1.4351, and the UTPD monitoring station. The fire alarm control panels shall report to existing annunciators at these locations or new annunciators shall be provided to receive the reports from the fire alarm control panel.

3. Remote reports shall include individual point information including location by building and room number, point status and circuit address.

**PART 3 - EXECUTION**

### 3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Installation shall be in accordance with manufacturer's published recommendations.

C. Installation of wiring and peripherals shall be in accordance with the recommendations of manufacturer of the material being installed.

D. Installation of the fire alarm system shall be as shown on the approved drawings. Changes to the approved drawings shall be submitted to EH&S for review and approval.

E. Installation personnel shall have available on the jobsite the approved shop drawings and submittal showing the complete scope of work throughout the installation.

F. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.

### 3.02 DEVICE PLACEMENT

A. General

1. Fire alarm system devices shall be installed in a manner that provides accessibility for periodic maintenance or replacement of entire device.

2. Fire alarm system devices shall not be installed in inaccessible locations.

3. Access to fire alarm system devices shall not be obstructed by conduit, plumbing, ductwork etc.

B. Smoke Detectors

1. Smoke detectors used for door release, automatic door control, or corridor detectors near any cross corridor door shall be located within five feet of the door. Detector shall be placed according to NFPA 72 Smoke Detectors for Door Release Service.

2. Where smoke detection is required for stairwell pressurization fan initiation, a smoke detector shall be located within ten feet of each stairwell entrance door as per NFPA 101.
3. Where smoke detectors are required for elevator recall service two smoke detectors shall be located on the ceiling within 21 feet of the centerline of each elevator door within the elevator bank under control of the detectors.

4. Smoke detectors shall be installed in locations that allow ready access for maintenance or replacement of the entire device. Where detectors cannot be accessed without the use of lifts or scaffolds, other means of smoke detection shall be applied. The floor area immediately under detectors must allow for the proper placement of a ladder. Special application detectors mounted above a suspended ceiling must be accessible from a ladder which is no higher than the ceiling height.

5. Where a smoke detector is installed in a room or closet, the detector shall be mounted as close as possible to the center of the room. Where a room has a door opening to a shower or lavatory mount the detector as far away from the door as code permits to reduce potential false alarm. In patient rooms mount the detector as far away from the head of the bed as is practical to reduce the potential for false alarm from breathing treatment mists. Maintain a consistent location for all like rooms.

C. Heat Detectors

1. Where heat detectors are used in lieu of smoke detectors due to environmental conditions, the heat detectors shall be spaced as required by NFPA 72.

2. Where heat detectors are used to initiate elevator shutdown functions the heat detectors shall be installed according to NFPA 72 Elevator Shutdown.

3. Heat detectors shall be installed in locations that allow ready access for maintenance or replacement of the entire device. Where detectors cannot be accessed without the use of lifts or scaffolds, other means of heat detection must be applied. The floor area immediately under detectors must allow for the proper placement of a ladder. Special application detectors mounted above a suspended ceiling must be accessible from a ladder which is no higher than the ceiling height.

4. Where a heat detector is installed in a room or closet, the detector shall be mounted as close as possible to the center of the room. Maintain a consistent location for all like rooms.

D. Duct Detectors

1. Exact duct detector placement shall be determined by the fire alarm system contractor. The fire alarm system contractor shall certify the correct placement and operation of the duct detector.

2. Duct detectors shall be installed in locations that allow ready access for maintenance. Where detectors cannot be accessed without the use of lifts or scaffolds, other means of duct smoke detection must be applied. The floor area immediately under detectors must allow for the proper placement of a ladder. Special application duct detectors mounted above a suspended ceiling must be accessible from a ladder which is no higher than the ceiling height.

E. Manual Stations

1. Manual stations shall be installed so that the operable part of the station is at a height of 48" above the finished floor.
2. Where manual stations are installed in a service corridor or other location where the potential for damage to the station from expected activities exists, a guard shall be installed to protect the station. Fire alarm contractor to coordinate identification of these locations with the general contractor.

F. Monitor Modules
   1. Monitor modules shall be placed where they are readily accessible for troubleshooting or maintenance.
   2. Monitor modules are to be located as close to the monitored device as is practical. Accessibility shall take precedence over proximity.

G. Visual Notification Devices
   1. Visual notification devices shall be wall mounted at a height of 83 inches above finished floor to the bottom of the lens.
   2. Ceiling mounted visual devices shall not be acceptable except where a hard ceiling exists and upon approval from EH&S.
   3. Where existing visual units are wall mounted at a code compliant height above floor, the new strobe unit may be installed at the same compliant height to avoid an uneven appearance.

H. Audible Notification Devices
   1. Audible notification devices shall be wall mounted at a height of 85 inches to the center of the device.
   2. Ceiling mounted Audible devices shall not be acceptable except where a hard ceiling exists and upon approval from EH&S.
   3. Where existing audible units are wall mounted at a code compliant height above floor, the new audible unit may be installed at the same compliant height to avoid an uneven appearance.

I. Combination Audible / Visual Notification Devices
   1. Audible / Visual notification devices shall be wall mounted at a height of 83 inches above finished floor to the bottom of the lens.
   2. Ceiling mounted Audible/Visual devices shall not be acceptable except where a hard ceiling exists and upon approval from EH&S.
   3. Where existing audible / visual units are wall mounted at a code compliant height above floor, the new strobe unit may be installed at the same compliant height to avoid an uneven appearance.

J. Door Holders
   1. Magnetic door holders shall be installed at a height of 86 inches or less from the finished floor to the center of the back box.

K. Relays
1. Fire alarm system relays shall be installed within three feet of the controlled device or circuit.

2. Relays mounted at motor controllers or other controlled equipment shall be mounted adjacent to, not above or below controlled equipment.

3. Relays mounted in open mechanical spaces above five feet shall have remote indicators mounted no higher than eight feet.

L. Remote Indicators

1. The remote indicator shall be wall mounted except where a hard ceiling is available. Remote indicators mounted in ceiling tiles shall not be acceptable. The remote indicator shall be mounted on the wall within six inches of the ceiling. Where the ceiling is above 8 feet or where location may be aesthetically challenging, the remote indicators shall be located at a designated location approved in writing by the Environmental Health and Safety Department.

2. Remote indicators in open spaces without ceilings shall be mounted no higher than eight feet. Remote indicators shall be clearly visible from the floor.

M. Isolation Modules

1. Isolation modules shall be installed adjacent to the terminal cabinet serving the equipment panel to which the isolated circuit(s) is connected. Separate wiring from each floor served shall be run to the terminal cabinet

3.03 NOTIFICATION

A. Disregards.

1. Prior to working on existing fire alarm system equipment or components the contractor must notify the Fire Life Safety Supervisor or the Safety Program Manager.

2. Contractor shall not perform any work or programming on the fire alarm system without the required outage and ILSM in place.

3. Contractor must verify the MDACC Monitoring Services has received the proper disregard for alarm, trouble and supervisory signals which may be generated by the contractor’s activity.

4. Where the contractor’s activities may prevent the MDACC Monitoring Services from receiving signals from an online system, the contractor must monitor the online systems and manually notify monitoring services of any alarm(s).

5. The contractor shall directly notify the Fire and Life Safety Supervisor or Safety Program Manager upon completion of the work.

B. System Shutdowns

1. Prior to performing any work which may impair any portion of an on line fire alarm system equipment or components the contractor must submit a request for system shutdown to the project manager. The contractor must inform the project manager of the specific location(s) affected and list the circuits which may be inoperable during the outage and the length of time the system will be impaired.
2. Requests for system shutdown must be made ten business days prior to performing the work.

3. Where a shutdown of four hours or greater is requested, all manual pull stations in all locations listed in the request must be have an out of service tag affixed. The tag shall be affixed to each manual station regardless of the stations ability to signal an alarm. The tag must give direction to call 911 in the event of a fire and the tag must list the anticipated time the station will be returned to service. The tag shall be affixed to each manual station at the beginning of the outage and remain affixed throughout the outage duration.

4. Where a shutdown of four hours or greater is requested, Interim Life Safety Measures may be mandated by the Environmental Health and Safety Department. The contractor shall review the measures prior to the scheduled shutdown and comply with all applicable measures.

5. The contractor shall directly notify the Fire and Life Safety Supervisor or Safety Program Manager upon completion of the work.

3.04 SYSTEM CIRCUITS

A. Field circuit wiring shall be installed as follows:

1. All wires serving each level shall be home run to the terminal box adjacent to the equipment panel serving that level. An exception to this requirement exists where a specific level's notification device wiring is routed to a remote NAC power supply on that level.

2. Where data circuits are required to be isolated between floors the isolation device shall be a separate device mounted at a readily accessible location adjacent to the fire alarm equipment cabinet or terminal cabinet. Combination devices such as a smoke detector / isolation device are not acceptable.

3. Individual data circuits shall serve each floor. The wiring shall be terminated in the terminal cabinet adjacent to the equipment cabinet serving that floor. Individual data wires terminated in the terminal cabinet shall not serve more than one floor.

4. System shall be designed so that any visual signal circuit, audible signal circuit and door holder circuit will serve not more than one floor.

5. Power and data wiring for annunciators shall be dedicated to the annunciators on each floor. Each floor's wiring shall be terminated in the terminal cabinet adjacent to the equipment cabinet.

6. Power and data wiring for relay driver and status monitor boards shall be dedicated to the boards on each floor. Wiring on each floor shall be terminated in the terminal cabinet adjacent to the equipment cabinet serving that floor. AHU status, override, and shutdown functions shall be wired in accordance with the recommendations of the manufacturer of the material being installed. Appropriate interfaces shall be used where required to ensure compliance with these recommendations.

7. All control wiring serving field devices shall have individual common wires to each device. All common wires shall be terminated individually at the terminal cabinet adjacent to the control panel.
3.05 CONDUIT SYSTEM AND WIRING

A. General

1. The fire alarm control panels, terminal cabinets, and the remote equipment cabinets shall not be used for junction boxes.

2. Any interconnections of system alarm wiring within the control panels or equipment cabinets shall be made using the manufacturer's terminal blocks intended for that application. Wire nuts are not allowed in control panel or equipment enclosures.

3. No more than two wires shall be connected at any single device or control panel terminal. No two wires of different gauge conductors shall be terminated at any single terminal.

4. Where end of line resistors are used to provide circuit supervision such as at a notification device, tamper or water flow switch contacts, the resistor shall not be placed under a terminal which has a circuit conductor of a larger gauge present. The end of line device must be remotely mounted if a separate termination point is not present.

5. Field wiring from each floor shall be routed directly to the terminal cabinet located next to the equipment cabinet which serves that floor. Circuit wiring shall not be shared between floors.

6. A terminal cabinet shall be installed adjacent to each equipment cabinet and control panel. Field wiring shall terminate in this cabinet. Field wiring shall not be run directly into equipment cabinets.

7. Communication lines between equipment cabinets within an individual building shall not be routed through equipment cabinets outside of that building. All building equipment cabinet communication lines shall be routed through that building's fire alarm control panel and shall allow for network disconnect without communication loss between equipment cabinets within that building.

8. The fire alarm system control panel shall not be used as a system equipment cabinet. The fire alarm control panel shall be a separate cabinet containing building control equipment only. Field detection, notification and control circuits shall not be routed to the fire alarm control panel. Fire alarm system equipment cabinet shall not be located in the fire command room.

9. Fire alarm system network communications and audio routing between building fire alarm systems shall be via dedicated fiber connections. Network fiber shall be routed from the buildings fire alarm control panel directly to the campus voice control panel location. Fiber connections shall be made using a single strand of single mode fiber.
10. Location of all controls, alarm actuating devices and audible alarm signaling devices shall generally be as shown on the Drawings. The Contractor shall not change locations indicated on Drawings. All location changes require the revisions to be made by an approved engineer or licensed fire alarm planner. In areas where there are no ceilings, install detectors against the building structure in accordance with manufacturer recommendations. In finished areas, devices shall be located in a symmetrical pattern relating to ceiling and/or wall features and, where applicable, ceiling mounted devices shall be located symmetrically with the ceiling grid centered in two directions. Vertically align pull stations and audible/visual alarm signaling devices. Where audio/visual, audio only or visual only devices are surface mounted to surface mounted junction boxes, install the manufacturer's skirt, or manufacturer's color-matched surface mount box or EH&S approved equivalent, which is designed to enhance aesthetics.

11. The correct electrical box shall be used for wall mounted notification devices. The notification device must fit flush against the wall. Surface mounted devices shall be used where flush mounting is not possible due to wall thickness. Surface mounting of wall mounted devices is not allowed where flush mounting is possible even if the flush mounting requires installing the correct back box.

12. Where fiber optic cable is used a fiber terminal box shall be installed adjacent to the fire alarm control panels or equipment cabinets served. Fiber optic cable shall not be run directly into the fire alarm panel(s). Cable terminal boxes placed within fire alarm panel enclosures shall not be acceptable. Fiber optic jumpers shall be used to complete the connection into the fire alarm panel. The fiber terminal box shall not have more than 50 percent of its capacity used during initial installation and shall be equipped with all terminals to allow for the addition of future connections. Each fiber strand terminated at the cable box shall be clearly labeled with the building and room number of its remote terminus. Each strand shall be labeled as to its function. Each jumper connected between the fire alarm panel and the fiber terminal shall be clearly identified. Writing on the cable with marking pens shall not be acceptable labeling.

13. The fire alarm system Contractor shall provide the correct style and length fiber jumpers between the fire alarm panel and the LUI terminals above the fire alarm panel. The LUI may use ST or SC style terminals.

14. The fire alarm system Contractor shall be responsible for the certification of the fire alarm system wiring. The fire alarm system Contractor must perform all necessary oversight and inspections to ensure code compliance of system wiring installed by others. The fire alarm Contractor shall check the wiring periodically during the installation process to ensure the wiring is not damaged or made susceptible to damage by other trades.

B. Wiring method shall be either conduit or structured cabling.

1. Conduit shall be installed wherever required by applicable codes.

2. Conduit shall be the preferred wiring method.

3. Where a building’s fire alarm system is being added to or modified, the wiring method shall match the building’s predominant existing wiring method.

C. Installations using conduit raceways.

1. Total wiring size including insulation shall be considered when sizing conduit runs and calculating the 40 percent fill.
2. Adequate J-boxes shall be installed to allow for wire removal or replacement.

3. Wherever splices are made in J-boxes, wires shall be labeled with the system circuit number and area served. Wire tags shall be affixed to identify the wires. Writing on wires with a marking pen shall not be an acceptable means of wire identification.

4. J-box covers shall be painted half red and clearly marked “Fire Alarm”.

5. Any system junction box containing wiring splices shall readily accessible for troubleshooting or maintenance without use of lifts or scaffolds. The floor area immediately under junction boxes containing spliced wires must allow for the proper placement of a ladder.

D. Installations using structured cabling.

1. Structured cabling method shall include the use of cable trays for the main wiring runs.

2. Where cable tray is provided above the ceiling, fire alarm cabling is to be routed in the cable tray, otherwise route fire alarm cabling in conduit from the fire alarm panel, between floors, and in equipment rooms. Plenum-rated fire alarm cable and bridle rings are acceptable for branch wiring. Between individual devices and the cable tray or bridle rings, utilize EMT conduit in partitions and stub-out above an accessible ceiling. Any junction boxes and covers required shall be painted red. All covers of junction boxes shall be labeled in bold, permanent marker “Fire Alarm”.

3. Where plenum-rated fire cable enters a device mounting box it shall be secured with a device to provide strain relief. A locking fitting designed for this purpose shall be attached to the mounting box and adjusted to secure the wiring and provide adequate strain relief to prevent plenum-rated wiring from pulling loose from device terminals. Wire ties used to provide strain relief shall not be acceptable.

4. Fire alarm system wiring shall not be attached to the underside of raceways or cable trays.

5. Fire alarm system wiring shall not exit through the bottom of a cable tray.

6. Where fire alarm system wiring is installed exposed, the wiring shall be installed in such a way that maximum protection from physical damage is provided.

7. Provide bushings, connectors, strain relief devices, boxes and covers specifically designed for structured cabling use.

8. Support all conduits and J-boxes above ceilings from the building structure.

9. All openings through walls, roof, etc., shall be sleeved.

10. Bushings and throats shall be installed for fittings, raceways, boxes or other enclosures prior to installing cables and wiring systems.

11. Coordinate cable tray installation with piping ductwork and light fixture installation. Maintain clearance inside cable tray for installation of cables. Install according to manufacturer’s instructions. Provide “Caution - Do Not Use As Walkway” signs suitably displayed as designated by the Owner.

12. All unused raceway openings shall be closed.
E. Control Panel Installation

1. Any interconnections of system alarm wiring within the control panels or equipment cabinets shall be made using the manufacturer’s terminal blocks intended for that application.

2. Each fire alarm control panel, equipment cabinet, terminal cabinet, battery cabinet or fire phone cabinet, shall be identified with a plastic tag permanently affixed to the cabinet and engraved with 1 inch letters identifying the cabinet.

3. Labeling must be attached to the inside of the fire control panel and equipment cabinet identifying the location of that panels 120 volt electrical source. This label is in addition to any labeling required under the electrical specifications.

4. The fire alarm control panels, the remote terminal cabinets and equipment cabinets shall be accessible for maintenance without special tools or ladders. Clearance around panel locations shall allow for the panel doors to be opened fully as designed by the equipment manufacturer. All fire alarm cabinets shall be keyed alike. A like key shall be used to key all fire alarm panels, cabinets and fire phone boxes. All keys shall be delivered to the environmental health and safety representative at the time of the acceptance test.

5. A terminal cabinet shall be installed adjacent to each control panel or equipment cabinet. The terminal cabinet shall be keyed with the same key as the fire alarm control panel. All field wiring serving this control panel including data circuits, notification circuits, and other data and power wires, shall be terminated in this panel and shall be permanently labeled. Writing on the wiring insulation with a marking pen as a method of labeling shall not be acceptable. Labels shall indicate the circuit number and the area served. This cabinet shall be accessible without special tools or ladders. Terminals in this cabinet will allow wiring to be disconnected for the servicing of individual circuits. Panel doors shall be a hinged door. Terminal cabinets and other fire alarm equipment shall be installed adjacent to, not above or below the equipment cabinets. Existing cabinets shall be expanded to provide sufficient terminals for any additional wiring added to the control panel or equipment cabinet. The terminal cabinet shall be used for wiring terminations only and shall not be used to house system components, relays, modules etc. The minimum size of any terminal cabinet shall be 24 inches by 24 inches and the cabinet shall be of sufficient size to allow for the expedient disconnection of an individual circuit without interruption of any other circuit. All terminals used shall be securely mounted to the backplane of the terminal cabinet. A minimum of 30 percent unused terminal capacity shall be provided in the terminal can. A 24 inch by 24 inch terminal cabinet shall have a minimum of six inches of clearance between the conduit entrance at the top of the cabinet and the top of the terminal strip to allow for wire routing. Where conduits enter at the sides or bottom of the cabinets additional six inches of clearance shall be provided at these locations. Where terminal cabinet size increases the clearances required shall also increase at a ratio of three inches additional clearance for each additional twelve inches of cabinet size.

6. Where a print hanger is installed in the fire command room, the top of the hanger brackets shall be installed at a height of fifty-two inches above the finished floor.

3.06 TESTING

A. General

1. All installation and acceptance inspections shall be performed by a licensed fire alarm technician or planner and be documented on the inspection form.
2. The Contractor shall direct, coordinate, and oversee the commissioning process and witness functional performance testing.

3. It is the Contractor’s responsibility to coordinate all testing between trades to ensure all necessary personnel are present and prepared at scheduled tests.

4. The Contractor shall perform all tests required by NFPA, State, and Local codes.

5. Acceptance test methods shall comply with NFPA 72.

6. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the Contractor. The following equipment shall be a minimum for conducting the tests:
   a. Ladders to access all installed equipment.
   b. Multimeter for reading voltage, current and resistance.
   c. Intelligent device programmer/tester.
   d. Laptop computer with programming software for any required program revisions.
   e. Two-way radios, flashlights, smoke generation-devices and supplies.
   f. Spare printer paper.
   g. Decibel meter.
   h. Voice intelligibility meter.

7. The Owner and MD Anderson EH&S Department shall be notified 10 days before the start of the required tests. The notice to the EH&S Department shall be in writing and sent directly to the fire and life safety supervisor. This written notice to EH&S shall be in addition to all other notices or posting of the inspection. All items found at variance with the applicable Codes, Drawings, or Specifications during testing or inspection by a representative of the Authority Having Jurisdiction shall be corrected by Contractor at no charge or expense to the Owner.

8. In addition to testing specified to be performed by the Contractor, the installation shall be subject to test by Owner.

B. Construction Inspections

1. The installing fire alarm system contractor shall perform the construction inspections required by the Texas Administrative Code (28 TAC Chapter 4.34.618).

2. The Owner and MD Anderson EH&S Department shall be notified 10 days before the start of the required tests. The notice to the EH&S Department shall be in writing and sent directly to the fire and life safety supervisor. This written notice to EH&S shall be in addition to all other notices or posting of the inspection.

C. Preliminary Testing
1. Preliminary testing shall include all testing necessary to certify the correct operation of the entire fire alarm system. The certification of the fire alarm system is required prior to presenting the system for acceptance testing. Preliminary testing shall include as a minimum a pre-functional test, functional performance test and an integrated system test. It is the contractor’s responsibility to schedule, perform and document these tests. A representative from the Environmental Health and Safety Department may monitor the preliminary tests but the presence of a representative of the Environmental Health and Safety Department is not required. No part of the fire alarm system is considered to be accepted at any point prior to the final acceptance test.

2. The Owner and MD Anderson EH&S Department shall be notified 10 days before the start of the required tests. The notice to the EH&S Department shall be in writing and sent directly to the fire and life safety supervisor. This written notice to EH&S shall be in addition to all other notices or posting of the inspection.

3. Preliminary testing shall include and document the systematic inspection of all system equipment and components to ensure compliance with these specifications.

4. Contractor shall provide skilled technicians to execute starting of equipment and to assist in execution of Functional Performance Tests. Contractor shall ensure that they are available and present during the agreed-upon schedules and for a sufficient duration to complete the necessary tests, adjustments, and problem solving.

5. Preliminary testing as required by code and state laws shall be performed and properly documented at the appropriate times during the installation process.

6. During construction, maintain Record marked-up Drawings and Specifications of all Contract Documents and Contractor-generated coordination Drawings. The Record Drawings and Specifications shall be delivered to the Owner both in electronic format and hard copies as required by the Owner.

7. On larger projects, multiple preliminary tests shall be performed as each portion of work completed dictates. All preliminary tests shall be completed prior to presenting the fire alarm system for acceptance testing.

8. Documentation of the preliminary testing shall be retained by the certifying company and presented at the acceptance test as part of the project documentation package.

D. Device testing.

1. All intelligent devices shall be tested and logged for correct address and sensitivity using test equipment specifically designed for that purpose.

2. Each notification device shall be individually tested and shall be logged by location. The test report shall include the device type, model number, circuit number, candela or wattage setting, individual device location and test results. For each device a passing note shall indicate the device meets all codes, specifications and manufacturer’s recommendations regarding placement, performance and workmanship.

3. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.

4. Wiring shields shall be tested for continuity and the results of testing shall be documented in the test report.
5. Correct deficiencies (differences between specified and observed performance) as interpreted by the Owner's Project Manager and retest the system and equipment.

6. Prepare required documentation prior to requesting the final acceptance test. Documents needed for final acceptance include:
   a. A copy of the preliminary test report. This copy to be retained by EH&S.
   b. System certification form. (009)
   c. Record Drawings from approved drawings.
   d. Site Specific software.
   e. Intelligibility report.
   f. SFM installation inspection form.
   g. Request for inspection form from the project manager.

E. Acceptance Testing

1. The Commissioning Plan required under Section 26.08 00 shall be provided to the Environmental Health and Safety Department for approval.

2. The commissioning plan shall comply with all requirements of these specifications.

3. A written request for the final acceptance test shall be sent to the fire and life safety supervisor 10 days prior to the requested test date. The requesting contractor shall be responsible for confirming the receipt of the acceptance test request. The request shall be sent directly to the Fire Life Safety Supervisor in addition to any other notices, requests, or postings of the acceptance test.

4. Every device and every function of the system is to be tested, verified and documented that it works properly and meets all contract and code requirements prior to requesting an acceptance test. Each and every interfaced function is to be tested, verified and documented that it works properly and meets all contract and code requirements prior to requesting an acceptance test.

5. Prior to conducting any acceptance testing the contractor shall present to the Owner documentation of the required testing reports and system certification. All pages of any report shall be identified and numbered to assure it is complete. All report documentation shall be dated and signed.
   a. A copy of the report of the inspection performed at the completion of the back-box installation but prior to the start of the cable installation. This report shall include the date of the inspection, the Texas Fire Alarm license number of the individual performing the inspection, the printed name of the individual performing the inspection, and the signature of the individual performing the inspection.
   b. A copy of the report of the inspection performed at the completion of cable installation but prior to the start of the device installation. This report shall include the date of the inspection, the Texas Fire Alarm license number of the individual performing the inspection, the printed name of the individual performing the inspection, and the signature of the individual performing the inspection.
c. A copy of the inspection performed at the completion of the device inspection but prior to activating the fire alarm system. This report shall include the date of the inspection, the Texas Fire Alarm license number of the individual performing the inspection, the printed name of the individual performing the inspection, and the signature of the individual performing the inspection.

1) A copy of the comprehensive preliminary inspection report performed prior to the start of acceptance testing. The preliminary report shall document the correct operation of the entire fire alarm system and complete detailed report of each and all interfaced functions. The preliminary inspection report shall note all system functions individually and all devices tested shall be identified by device type, custom label, system circuit and address numbers. The preliminary test report shall comply with the requirements of NFPA 72 chapter 10. This report shall include the date of the inspection, the Texas Fire Alarm license number of the individual performing the inspection, the printed name of the individual performing the inspection, and the signature of the individual performing the inspection.

2) The completed and signed Certificate of Compliance in accordance with NFPA 72 paragraph 2.2.2 and Texas administrative Code Title 28 Part 1 Chapter 34 Subchapter F Rule 34.617. This certificate shall include the date of the certification, the Texas Fire Alarm license number of the individual performing the certification, the printed name of the individual providing the certification and the signature of the individual providing the certification. All applicable information shall be correctly detailed on this certification. This certification shall include the MD Anderson project number to correctly identify the scope of work referenced in the certification.

3) Approved Record Drawing shall be provided to EH&S at the time of the acceptance test. This Record Drawing may be a markup drawing provided a date for delivery of permanent drawing has been documented.

4) Audio intelligibility report shall be provided to EH&S at the time of the acceptance test.

5) Site specific software shall be provided to EH&S at the time of the acceptance test.

6. The fire alarm Contractor shall document each device failure and installation discrepancy at the time of the acceptance test. A written explanation of each discrepancy and failure shall be included as part of the installation documentation.

7. In the event of the systems failure to perform as specified and programmed during the ATP procedure, at the discretion of the Owner or at the discretion of the Authority Having Jurisdiction, the test shall be terminated. The contractor shall repeat the preliminary test prior to requesting further acceptance testing.

8. The Contractor shall retest the system, correcting all deficiencies and providing test documentation to the Owner.

9. The certifying contractor shall provide written explanation of any system failures or non-compliance discovered at the acceptance test. This documentation shall be included in the record documents.
10. The correcting contractor shall document the correction of each discrepancy noted during the ATP. Conducting multiple tests to determine the status of the discrepancy list is not acceptable procedure. Retesting shall be scheduled for and limited to those documented corrections except where a percentage of devices are required to be retested due to system software changes.

11. In the event that software changes are required during the ATP, a utility program shall be furnished by the system manufacturer to compare the edited program with the original. The utility shall yield a printed list of the changes and all system functions, inputs and outputs affected by the changes. The items listed by the program shall be the minimum acceptable to be retested before calling for resumption of the ATP. The printed list and the printer log of the retesting shall be submitted before scheduling of the ATP.

12. The Owner or the Authority Having Jurisdiction may elect to require the complete ATP to be performed again if, in their opinion, modifications to the system hardware or software warrant complete retesting.

13. All acceptance testing for this project will be accomplished by the Contractor in accordance with the procedural specification listed herein.

14. Every device and every function of the system is to be tested and verified that it works properly.

15. If the system does not function properly and repairs or reprogramming are required, then a retest will be necessary. If multiple discrepancies are found the contractor shall be required to repeat the pretests prior to repeating the final acceptance test.

16. All acceptance testing and documentation shall conform to NFPA 72 Chapter 10, Section 10.4 and this specification. The Contractor shall be responsible for the performance of the Acceptance Test Procedure (ATP), demonstrating the function of the system components, circuits and programming. The acceptance test shall be performed for Owner approval.

17. Prior to testing, the Owner shall be provided Drawings showing the correct address for all addressable alarm initiation devices. The addresses shall be shown in their respective locations for the device on the Drawings. Signals shall be sequentially numbered as the address of the controlling module. Each notification device shall be individually tested and shall be logged by location.

18. The Acceptance Test Procedure shall include but not be limited to the following:

a. A systematic inspection of all system equipment and components to ensure compliance with these specifications.

b. System mapping feature shall not be disabled at the time of acceptance.

c. A reboot of all the system components shall be performed to ensure restart of all fire alarm system equipment without system troubles or mapping errors.

d. A comprehensive test of all peripheral devices.

e. Testing of all network annunciators to ensure correct display of added points.
f. Manual pull stations shall be tested by pulling the handle and reset with key. The break rod shall be installed at the time the manual pull station has passed the acceptance test. The keys for each manual pull station shall be delivered to the Environmental Health and Safety representative at the time of the acceptance test.

g. Smoke detectors shall be tested using smoke detector test smoke approved for that purpose.

h. Smoke detectors shall be tested with the alarm verification feature turned off.

i. Each visual notification device shall be checked for correct candela settings. Correct operation and jumper settings of each notification devices shall be verified and listed individually in the inspection report.

j. Peripheral devices shall be observed to be free of dust, dirt and paint. Strobe lenses shall be clear.

k. Acceptance tester shall demonstrate and document the accessibility of all installed devices. Use ladders and test equipment as required by specification. Scaffolds and lifts are not acceptable for access to devices.

l. Contractor shall perform Audio Intelligibility testing and sound level testing, providing test results in an acceptance testing report.

m. The system shall be tested in full general alarm mode for a minimum of 10 minutes.

n. A complete test of all system functions and controls.

19. In addition to the basic system functions, acceptance testing shall include but not be limited to the following systems as appropriate.

a. Elevator recall.

b. Elevator shunt trip.

c. AHU shutdown.

d. Sprinkler system monitoring modules.

e. Smoke damper operation.

f. Fire/smoke shutter operation.

20. Secondary power capabilities shall be demonstrated as follows:

a. System primary power shall be disconnected for a period of seven (7) hours. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period of five (5) minutes.

b. System primary power shall be restored for 48 hours and system- charging current shall be normal trickle charge for a fully charged battery pack.

c. System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.

21. Fireman’s HVAC override system functions shall be demonstrated as follows:
a. On/off control of each controlled element and test for interaction of other automatic and manual control functions while in the override mode.

b. Correct status display of monitored elements.

c. Correct logging of activity to printer and historical memory as programmed.

d. Contractor shall provide skilled technicians to execute testing. Ensure that they are available and present during the agreed-upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

22. Correct message display, building, room number, and icon location for each alarm input at the control panel, each remote annunciator display and at the remote voice control panel.

23. Correct printer logging at the building control panel.

F. Documentation

1. Record Drawings:

   a. The Contractor shall provide a complete and correct set of printed record drawings to be installed in the fire command room. The printed record drawings provided shall be thirty inches by forty inches. This set of record drawings shall be in addition to all other drawings required. The printed record drawings shall be available at the time of the acceptance test. These drawings shall not be marked or modified during the acceptance test.

   b. The Contractor shall provide a complete and correct set of printed record drawings to be installed in the fire command room and a separate complete set of as built drawings shall be delivered to the EH&S Fire Safety Project Manager. An electronic copy of the record drawings shall be provided to the EH&S representative on a CD in a DXF format. This set of electronic record drawings shall be in addition to all other drawings required. The electronic drawings shall be available at the time of the acceptance test.

2. Contractor shall prepare Pre-functional Checklists and Functional Performance Test (FPT) procedures and execute and document results. All Pre-functional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Owner for review and approval.

3. No documentation shall be marked as “passed” by the Environmental Health and Safety representative until the entire installation, including all peripheral devices, has met all code and specification requirements. An exception to this requirement would be a project designed and installed in phases with appropriate phased drawings previously submitted for review by EH&S.

4. Contractor shall provide Owner with documentation required for Commissioning work. At minimum, documentation shall include: Detailed Start-up procedures, Full sequences of operation, Operating and Maintenance data, Performance data, Functional Performance Test Procedures, Control Drawings, and details of Owner-Contracted tests.

5. Contractor shall submit to Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.
6. Contractor shall confirm all equipment listed on the bill of materials has been installed or delivered to EH&S.

7. Attic stock shall be transferred to the Environmental health and safety department prior to acceptance of any system or modification.

8. Contractor shall have readily available all replacement components necessary for emergency warranty repairs. Contractor shall provide a site specific list of service repair part numbers for system components. Standard manufacturer’s service repair parts list is not acceptable. The exact parts used on site shall be listed with the correct service repair part numbers.

9. Contractor shall review and approve other relative documentation for impact on FPT’s of the systems:
   a. Shop Drawings and product submittal data related to systems or equipment to be commissioned. The Subcontractor responsible for the FPT shall review and incorporate comments from the Owner and A/E via the Contractor.
   b. Incorporate manufacturer’s Start-up procedures with Pre-functional checklists.
   c. Draft Electrical Testing Agency (ETA) Reports: Review and provide comments to Owner.
   d. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT’s.
   e. Completed equipment Start-up certification forms along with the manufacturer’s field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT’s.

10. Final ETA Reports: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT’s.

11. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

3.07 TRAINING

A. Formal training for the operation and maintenance of all fire alarm equipment and the systems specified herein shall be given by factory trained and certified personnel.

B. The training shall consist of a minimum of three (3) complete 4-hour training sessions and an eight hour follow up training. The follow up training shall take place approximately six (6) months after the date of acceptance.

1. The first and third sessions shall be for operational and general maintenance subjects.

2. The second and forth sessions shall be for technical training.

3. The follow up session shall be for warranty issues and retraining.
C. The training shall not take place until all system devices, annunciators and controls have been installed and certified operational by the licensed fire alarm technician. The certifying technician shall be present throughout the training sessions.

D. The specified training shall be given at a location designated and provided by the Owner for a minimum of ten (10) personnel selected by the Owner, in addition to any necessary on-Site orientation and training.

E. A training program shall be submitted with material, instructors’ qualifications, and proposed schedule, a minimum of sixty (60) days prior to the proposed training for each building system.

F. The Owner reserves the right of approval of any training course, material, instructor and schedule.

G. Contractor shall provide a site specific list of service repair part numbers for system components. Standard manufacturer’s service repair parts list is not acceptable. The exact parts used on site shall be listed with the appropriate service repair part number. The service part number shall be the only part number needed for correct replacement of the service part.

H. A minimum of twelve (12) bound copies of training material shall be provided at the time of training, with four (4) additional copies submitted at the time of Substantial Completion included in the Owner’s Operating and Maintenance Manuals.

END OF SECTION 28 30 00
## FIRE ALARM SYSTEM PRICING DETAIL

**Project Name:** New Research Building  
**DATE:** March 06, 2008

### PROJECT NUMBER: # 08-0001

#### Control Equipment

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#### Installation Equipment

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<tr>
<th>Description</th>
<th>Part#</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Extended Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire #18 shielded</td>
<td>676 w</td>
<td>.70 ft.</td>
<td>1600</td>
<td>$1120.00</td>
</tr>
<tr>
<td>Caddy Bar</td>
<td>655 w</td>
<td>$3.50</td>
<td>40</td>
<td>$140.00</td>
</tr>
<tr>
<td>Boxes</td>
<td>674 w</td>
<td>$1.20</td>
<td>40</td>
<td>$40.00</td>
</tr>
</tbody>
</table>

#### Labor

<table>
<thead>
<tr>
<th>Description</th>
<th>Part#</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Extended Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Labor</td>
<td>N.A.</td>
<td>$60.00</td>
<td>10</td>
<td>$600.00</td>
</tr>
<tr>
<td>Installation Labor</td>
<td>N.A.</td>
<td>$50.00</td>
<td>60</td>
<td>$3000.00</td>
</tr>
<tr>
<td>Technical Labor</td>
<td>N.A.</td>
<td>$90.00</td>
<td>10</td>
<td>$900.00</td>
</tr>
<tr>
<td>Programming</td>
<td>N.A.</td>
<td>$90.00</td>
<td>10</td>
<td>$900.00</td>
</tr>
<tr>
<td>Test / commissioning</td>
<td>N.A.</td>
<td>$50.00</td>
<td>12</td>
<td>$600.00</td>
</tr>
</tbody>
</table>

#### Outside Purchase / Subcontract

<table>
<thead>
<tr>
<th>Description</th>
<th>Part#</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Extended Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduit Riser (Installed)</td>
<td></td>
<td>$1900.00</td>
<td>1</td>
<td>$1900.00</td>
</tr>
<tr>
<td>Riser Terminal Cabinets</td>
<td></td>
<td>$160.00</td>
<td>3</td>
<td>$480.00</td>
</tr>
</tbody>
</table>

**TOTAL** = $20,480.00
END OF ATTACHMENT “A” - SECTION 28 30 00
PRERECORDED DIGITAL VOICE MESSAGES TEXT

ALL CLEAR
Attention, may I have your attention please.
The fire alarm condition has been cleared.
I repeat.
The fire alarm condition has been cleared.
All systems have been returned to normal.
Thank you for your co-operation.

ALL CLEAR IN SPANISH
Su atencion, por favor
El estado de alerta de fuego ha sido resuelto.
Repite
El estado de alerta de fuego ha sido resuelto.
Todos los sistemas se han normalizado.
Gracias por su cooperacion

TESTING
Attention, may I have your attention please.
We are conducting a test of the life safety system.
Please disregard the audio signals and flashing lights, as they are only a test.
Thank you.

TESTING IN SPANISH
Su atencion, por favor
Estamos conduciendo una prueba del sistema de seguridad.
Por favor, ignore las senales de audio y las luces intermitentes, porque son solo una prueba.
Gracias

TESTING COMPLETED
Attention, may I have your attention please.
We have completed our test of the life safety system.
All systems have been returned to normal.
Thank you for your co-operation.

TESTING COMPLETED IN SPANISH
Su atencion por favor
Hemos completado nuestra prueba del sistema de seguridad.
Todos los sistemas se han normalizado.
Repite
Hemos completado nuestra prueba del sistema de seguridad.
Todos los sistemas se han normalizado.
Gracias por su cooperacion.
Attention, may I have your attention please.
This is a practice fire drill.
Please follow RACE procedures.
Thank you.

DRILL MESSAGE IN SPANISH
Su atención por favor.
Este es un simulacro de incendio.
Por favor, siga los procedimientos de R-A-C-E
Gracias

Attention, may I have your attention please.
This has been a fire drill.
I repeat
This has been a fire drill.
This is an all-clear notification.
Thank you for your cooperation

DRILL COMPLETED IN SPANISH
Su atencion por favor.
Esto ha sido un simulacro de incendio.
Repito.
Esto ha sido un simulacro de incendio.
Esta es la senal de finalizacion del simulacro.
Gracias por su cooperacion.

END OF ATTACHMENT “B” - SECTION 28 30 00
Attachment “C”

DEVICE LABELING CONVENTION FOR FIRE ALARM SYSTEMS

BUILDING

ACB8.1608 CORR M5-35-0

FLOOR OR LEVEL

ACB8.1608 CORR M5-35-0

ROOM

ACB8.1608 CORR M5-35-0

In Corridor Outside Room

ACB8.1608 CORR M5-35-0

Fire Alarm System POINT IDENTIFIER

ACB8.1608 CORR M5-35-0

Include Unit Number On Duct Detectors Etc.

ACB8.1608 AHU7 M5-35-0
Typical Labels:
G11.3615 CORR M5-95
G11.3711 CORR M5-96
G11.3674 CORR M5-97
G11.3678 CORR M5-98
G11.3681 CORR M5-99
G11.3631 CORR M5-100
G11.3659 CORR M5-102
G11.3362 CORR M5-103
G11.3631 M5-107
G11.3613 M5-108
G11.3662 CORR M5-109
G11.STAIR AA M5-114
G11.3536 M5-115
G11.3532 M5-116
G11.3461 M5-117
Y5.5811 CORR M6-4
S5.8228A M7-23
TB.ELEV TB SD M1-9
G11.3461 Mech M1-10
G10.3300 Elec M1-9
G8.1010 Mach M5-15

ADDITIONAL NOTES:
1. Device types report separately and are not needed in the label.
2. If a system is used which cannot report device types separately the device type shall follow
the location and precede the device identifier:
   a. G11.3659 CORR Pull M5-102
   b. Y5.5811 CORR Smk Det M6-4
3. If in doubt contact MD Anderson EH&S Department for direction.

END OF ATTACHMENT “C” - SECTION 28 30 00
UNIFORM FIRE ALARM CONTROL PANEL TEST FEATURES

3.08 OPERATIONAL INSTRUCTIONS AND EXPLANATION OF FUNCTIONS

A. The test functions of our fire alarm panels have been revised and made uniform for all buildings. The new format includes changes meant to provide an increased level of safety, simplified operator control and minimizes disruption of building operations during testing, maintenance and fire drills.

B. The most significant change is the elimination of a test program. The test functions are built into each system’s custom control equations and works in conjunction with, not in lieu of, the system’s operating program.

C. The new functionality consists of three elements:

1. FLOOR TEST
   a. The first element is the selection of the floor to be placed in test mode. One or more floors may be placed in the test mode by activating specific pseudo point(s) at the control panel. Placing a floor in test mode prevents all normal functions from occurring due to an alarm initiated from that floor except that any device activated will report to that system’s control panel and annunciators. This allows for discreetly testing the performance of all initiating devices without the need for bypassing or disconnecting control or signaling devices. All floors other than the one(s) in test mode will continue to operate normally without any limited functionality upon alarm initiation.
   b. The pseudo points used for the floor selection are the same in all panels. Pseudo point 700 is used for the basement, 701 for 1st floor 702 for the 2nd floor etc. For buildings with levels lower than basement level, pseudo points 699, 698 etc. are used.

2. ENHANCED TEST FUNCTIONS
   a. The second element allows for the activation of selected functions for further testing or drills. These features are added to the floor(s) in test by activating one of three buttons on the face of the control panel.
      1) The first button labeled Notification Test, when activated, will enable the audio and visual notification devices on the floor(s) in test mode.
      2) The second button labeled AHU / Damper test, when activated, will enable AHU shutdown (either by duct detector or by floor as programmed) on any floor(s) in test mode.
      3) The third button labeled Door Test, when activated will enable the door release feature on any floor(s) in test mode.

3. INDEPENDENT TEST FUNCTIONS
   a. The third element allows for the testing and maintenance of elevator or sprinkler systems without the need to disable individual points or to place any floors in test mode. These features are used independently, without the need for floor test activation.
1) The fourth button labeled Elevator Test, when activated, allows for the testing of elevator recall functions without the need to disable any fire alarm signaling or control functions. Alarms initiated from elevator lobby or elevator machine room smoke detectors will report to the fire alarm system control panel and annunciators and activate elevator recall functions as programmed without activating fire alarm signaling or control functions. All other system initiation devices including elevator shunt trip will activate control and signaling devices as programmed. This feature allows the inspector to expeditiously test lobby detectors and the associated recall functions moving from floor to floor without activating alarm signal or control devices.

2) The fifth button labeled Sprinkler Test, when activated, allows for the testing of sprinkler flow switches without the need to disable any fire alarm signaling or control functions. Sprinkler flow switches will still report to the fire alarm panel and annunciators when activated without activating fire alarm signaling or control functions. This feature allows for the refilling of sprinkler risers without the need to put any floors in test and will allow the sprinkler techs to identify those flow switches which may be in need of adjustment because they activated too soon.

D. Note: Activation of any test feature will cause a system trouble. System trouble reminder will repeat if system is left in the test mode.

END OF ATTACHMENT “D” - SECTION 28 30 00
TEMPORARY FIRE ALARM PROTECTION

TEMPORARY PROTECTION SHALL RESEMBLE THIS DESCRIPTION.

3.09 FIRE ALARM DEVICES ARE FOUND IN ALL AREAS OF ALL BUILDINGS AND IMPACT ALMOST ALL CONSTRUCTION PROJECTS LARGE AND SMALL. THIS DESCRIPTION WILL HELP THE CONSTRUCTION PROCESS BY GETTING THE FIRE ALARM DEVICES “OUT OF THE WAY” WHILE MAINTAINING AN ACCEPTABLE LEVEL OF LIFE SAFETY PROTECTION.

A. Fire alarm system issues should be considered during the design and review process. Any project which requires removal or replacement of detection or notification devices should include a survey by a professional fire alarm engineer or designer. Since these projects will eventually require the services of a fire alarm company to do the replacement or relocation work and the fire alarm company representative has to make an initial walkthrough inspection to determine the price of the work needed, the survey could take place at that time. The fire alarm company representative can determine the amount of temporary coverage needed, the best way to demolish existing devices, and identify any control functions which may be affected by the construction work.

B. Prior to the removal or demolition of any fire alarm equipment provide separate temporary coverage to the construction area.

1. Temporary wiring should be run separately from existing wiring or conduit.

2. Temporary wiring should be placed where it will be out of the way throughout the construction process.

3. Consideration should be given to the eventual removal of the wire upon completion of the project.

4. Temporary wiring may be identified by placing small amounts of construction tape along its path to prevent accidental demolition of the temporary wiring.

5. Temporary protection devices should include heat detectors, manual pull stations at exits, smoke detectors where control functionality is required such as active elevator lobbies, audible and visual notification devices appropriate for the area, and any devices which need to be functional during the construction process.

6. Additional temporary wiring may be needed to replace circuits which are routed beyond the construction area to active fire alarm equipment.

7. The temporary fire alarm coverage should be properly tested and documented before proceeding with the demolition of existing devices. Devices beyond the construction zone which may have been affected by system changes should also be tested.

C. Demolition of existing equipment should begin by the fire alarm contractor disconnecting the existing circuits at the control panels, terminal cans or junction boxes as appropriate and rerouting any active circuits around the construction area utilizing the previously installed temporary wiring.
1. A general functional test of the affected areas should be done at this time.

2. Existing fire alarm devices and equipment should be removed and given to the MD Anderson Environmental Health and Safety Representative. The Contractor is now free to remove conduit and wiring without risk to life safety or control equipment.

END OF ATTACHMENT “E” - SECTION 28 30 00
DOOR HOLDER POWER AND CONTROL NAC
CONCEPTUAL DRAWING

Conceptual Drawing of Typical Door Control NAC

- Drawing depicts a combination of magnetic door holder circuits and door interface relay circuits.
- Remote indicators may be required as per specification.
- Placement of NAC panel and relays shall comply with specifications.
- Where non-addressable NACs are used, additional equipment and additional NACs may be required to provide correct sequence of operation.
- Expanded NAC modules may be used to provide additional control.

END OF ATTACHMENT “F” - SECTION 28 30 00