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INTRODUCTION

These Design & Construction Standards are intended to create a common basis for the design, construction, maintenance, renovation and general care of facilities on The University of Texas at Austin campuses, which includes the Main Campus, the J.J. “Jake” Pickle Research Center campus, and Marine Science Institute, as well as other UT Austin sites, such as the MacDonald Observatory, Winedale Historical Center, Lost Pines Biological Research Center, and Brackenridge Field Laboratory. The standards are the result of years of experience in designing, building, and operating facilities on the campuses, with a historical knowledge of what has served the University well. As such, they form the preference and knowledge base for all facilities on the campuses. It should be clearly understood by all persons using these standards that they are not specification documents, nor are they procedures for construction. Design and document preparation continue to be the design professional’s responsibility. Means, methods, techniques, and procedures remain the Contractor’s responsibility.

These standards are to be used by all persons involved with facilities on The University of Texas at Austin campuses. Such persons can include, but are not limited to, administrators, user-groups, faculty, staff, architects, engineers, interior designers, contractors, subcontractors, trades-people, suppliers, vendors, University construction and maintenance shop personnel, etc.

These standards represent the preferred construction products, materials, details and systems to use in the development of programs, plans, specifications and construction documents for UT Austin projects. Components shall be selected through pre-qualification guidelines including, but not necessarily limited to, performance characteristics, code/regulatory compliance, maintenance control, and inventory standardization. These standards represent the intent of the University to address the following primary criteria while providing optimal life cycle cost benefit to the University:

1) Safety
2) Reliability
3) Maintainability
4) Efficiency
5) Sustainability

The intent of these standards is not to limit creative solutions. The University will consider requests for substitutions or variances in order to provide the best benefit to the University and will typically require a life cycle cost analysis to be completed as part of the substitution or variance process as provided in the following articles. When these standards refer to a single manufacturer, it is not intended to exclude all other alternatives for all projects, unless specifically stated.

MODIFICATION PROCEDURES

The University of Texas at Austin Design & Construction Standards is intended to be a continually evolving document. As new systems, components and techniques become available and they are deemed appropriate for use as a standard at The University of Texas at Austin, they will be incorporated into these Standards. As standard details and systems are tested in the field and modification is deemed appropriate, those changes, refinements and modifications will be incorporated into these Standards.
The Design & Construction Standards are the property of The University of Texas at Austin at all times and are intended solely for projects on The University of Texas at Austin campuses. They are not to be copied for use by others nor used on projects outside of The University of Texas at Austin campuses.

These Standards shall be provided to those individuals and firms who are providing design and construction services to the University.

No portion of this manual may be reproduced in any specification intended to be a part of construction documents without the prior written permission of The University of Texas at Austin Campus Planning and Facilities Management.
## DEFINITIONS

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<th>Definition</th>
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<td>Campus Planning</td>
<td>Campus Planning, UT Austin</td>
</tr>
<tr>
<td>Contractor</td>
<td>Company performing construction under contract to UT Austin</td>
</tr>
<tr>
<td>Department</td>
<td>Academic, Administrative, or Auxiliary Department of UT Austin</td>
</tr>
<tr>
<td>Design Professional</td>
<td>Anyone performing design services under contract to UT Austin</td>
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<tr>
<td>EHS</td>
<td>Environmental Health and Safety, UT Austin</td>
</tr>
<tr>
<td>FS (Facilities Services)</td>
<td>Buildings, grounds, equipment, etc. operated by UT Austin Facilities Services Department</td>
</tr>
<tr>
<td>OFPC</td>
<td>Office of Facilities Planning and Construction, UT System</td>
</tr>
<tr>
<td>Owner</td>
<td>University of Texas System, UT Austin</td>
</tr>
<tr>
<td>PM/CS</td>
<td>Project Management and Construction Services, UT Austin</td>
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<tr>
<td>PSP</td>
<td>Professional Service Provider</td>
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<tr>
<td>University</td>
<td>UT Austin or University of Texas System</td>
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<tr>
<td>University Project</td>
<td>University personnel designated as project contact(s)</td>
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<tr>
<td>Representative</td>
<td>Utilities and Energy Management, UT Austin</td>
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Design & Construction Standards, Revised November 2007
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DESIGN AND CONSTRUCTION STANDARDS

DELIVERABLES

At Programming, Design and Construction Document Phases

Document Format
Number all pages of each document. Preferred sheet size is 24” X 36”, maximum is 34” X 44”. North shall be at top of sheet or to the left. Include graphic scales on all plan sheets.

Review Sets
For Major capital construction projects deliver review plans and bid set prints to UT Austin directly to the departments required:

(3) copies to PM/CS at 1800 Manor Road Rm 3.102,  
(2) copies to U&EM at Services Building 100 W. 24th St Room 223,  
(1) copy to Telecommunications at Services Building 100 W. 24th St Room 232A  
(1) copy to EH&S at Service Building 304 E. 24th St Room 202,  
(1) copy to ad hoc building chairman.

Project Management and Construction Services Projects
Deliver five (5) copies to Project Management and Construction Services, FC1 Facilities Complex Bldg#1, 1301 East Dean Keeton. Austin, TX 78722.

Digital File Submittal
The PSP shall utilize a CADD drawing-layering standard comparable to the current AIA standard and shall review proposed standard with the Owner prior to commencing drawing preparation.

The PSP shall provide the University, at between one month and three months prior to Substantial Completion, with a complete current electronic set of the architectural floor plan drawings with room names, room numbers, and room square footages indicated. The PSP shall provide 2 copies of electronic media on CD Rom. The PSP shall not be relieved of responsibility when files are delivered if the files do not meet established requirements or are defective. University shall verify all files and The PSP shall be notified of acceptance.

Room data information is needed for each project so that the University can keep its facility inventory current and the Department of Institutional Studies can fulfill its obligation to notify The Texas Higher Education Coordinating Board of facility inventory changes. Room names, room numbers, and square footage shall be linked to data fields using appropriate attributes for text and number fields. Microsoft Access 2000 or newer shall be used as the database. The PSP shall provide data layering proposal for approval.

The PSP, as a basic service, shall utilize a CADD drawing-layering standard comparable to the current National CAD Standard version 3.1, in conjunction with the standards at PMCS and shall review proposed standard with the Owner prior to commencing drawing preparation. Provide all disciplines of required construction document drawings in electronic dwg file format readable by AutoCAD 2007 or latest version used by Owner. Verify database
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DESIGN AND CONSTRUCTION STANDARDS

for correctness prior to delivering data files. Provide these files to owner no later than at the conclusion of the Bid or Pricing Phase. Provide 1 electronic copy on CD.

Utility Plans are to follow the UT Austin Utility and Energy Management layering protocol included at the end of this section.

At Construction Phase:

The PSP:
The PSP shall revise the drawings and specifications upon Final Completion of the construction, to incorporate all Addenda, all Change Orders for the Work, and any modifications recorded by the Contractor on the As-Built Drawings and Specifications maintained at the job site. The PSP shall label the revised drawings and specifications as “Record Drawings” and “Record Specifications” and shall deliver copies to the University for record purposes, as follows:

All project drawings: provide 2 copies of electronic media on CD readable/writeable using AutoCAD 14 or 2000 or newer. MicroStation J or SE or newer shall also be accepted for the deliverables, but Microstation users shall be required to save to Autocad format.

All project specifications in electronic format on CD ROM in MSWord 2003 or newer version.

Contractor (Construction Manager, or Design.Builder, UT construction personnel):
Contractor shall provide the University, at between one month and three months prior to Substantial Completion, with a complete set of the as-built Telecommunication Drawings and Telecommunication Port Log for the University’s use in coordinating selection and procurement of telephone/data equipment.

As a requirement for certification of Substantial Completion, Contractor shall reproduce two (2) copies of the current As-Built Drawings and Specifications maintained at the job site and provide these copies to the Owner. These documents shall be labeled “Interim Record Drawings and Specifications”, and are required to assist the Owner in the operation of the facility until Final Completion is accomplished and the final As-Built Drawings and Specifications are provided to the Project Architect to prepare the final “Record Drawings” and “Record Specifications”.

Project Management and Construction Services Projects
Provide Institutional Studies with room information and a copy of final design package. Update with any changes made during construction. The PSP and contractor shall provide deliverables as described above.

Site Utilities
Major capital construction projects
Design professional team shall review UT supplied survey and utility plans and obtain additional information on utilities from the City, Southwestern Bell, Southern Union Gas, etc., as necessary. Request verification excavations at any potential utility conflict points. Coordinate all required utility tie-ins. Review utility infrastructure and tie-in proposals with OFPC & UT Austin project representative. Obtain clearances for all utility tie-ins and City
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DESIGN AND CONSTRUCTION STANDARDS

street/easement crossings prior to going to bid. Identify projected cost for permits, meters, etc., and include in budget. If a project requires that UT Austin utilities cross a City street, the consultant shall investigate and submit to UT Austin all City of Austin requirements for any license agreement(s) that may be required.

Site Usage
Design professional shall specify that Contractor observe UT Austin EHS requirements per Section 02070 of this standard and obtain any required permits and comply with City regulations for work within City easements or right-of-way. Documents shall note that parking is not available on campus except in public parking garages at posted rates, on an available basis. Therefore, contractor shall park offsite and shuttle workers to the job or park within the construction fencing.

1. Storm Water Pollution Prevention Plan (SWP3)
Design professional shall submit the SWP3 meeting all EPA requirements to UT Austin EH&S at least two weeks prior to the submission of final construction documents (bid set) plans and specifications to UT Austin which reference storm water controls.

Tree Protection
Conform to City of Austin guidelines for tree protection during construction. In general, fence off areas within tree driplines and prohibit all construction activity within fence. Cover area within dripline with 4” of shredded mulch and maintain ground moisture sufficiently to keep trees in a healthy growing condition throughout construction. Where the above is not possible, an arborist shall be hired to provide an appropriate tree protection plan and monitor tree health during construction.

Closeout Submittals
Major capital construction projects
Construction documents shall clearly require contractor to provide two (2) copies of the marked-up field set of as-builts and 2 copies of the draft O&M Manuals to UT Austin for use by building maintenance during user training/inspection. No later than two weeks prior to substantial completion, contractor shall deliver all required closeout submittals, including, O&M manuals, test reports, warranties, keys, and spare parts. Contractor shall submit one copy of final as-builts in digital form, one copy printed on mylar and two blueline prints as soon after substantial completion as is possible, but no later than 90 days after substantial completion.

Contractor shall maintain separate as-built drawings of water and sewer lines, not on the same drawing. Deliver (2) copies to Utilities & Energy Management Department.

Appendix to DELIVERABLES:

UNIVERSITY OF TEXAS AT AUSTIN
GENERAL NOTES:

1) Each layer may have several linetypes or symbols. Be sure to use the correct color and linetype (*NOT “bylayer”*). Refer to separate linetype and symbol legends.

2) The overall goal is to strive for as few and as uniformly numbered layers as possible and mostly just to keep utility systems together. Separating (by layer) typically will do this according to system ownership. (UT, City of Austin, SW Bell, Southern Union Gas, etc.)

3) Text and leaders associated with a particular item (unless otherwise noted) will all go in the same layer as that item group, including depths, but *NOT* elevations.

4) Any item group described, as a system will have all symbols and text associated with that system also in the same layer. (Examples: Water piping has meters and irrigation systems, thrust blocks and some connection fittings; Grease traps have sanitary & vent piping, lids & CO’s; Pond and fountain piping systems have pumps; Storm piping has manholes and lids) Note that consideration was also given to layer separation to use to create and update keymaps. Written procedures for this facilities management task is forthcoming.

5) Utility component numbering will accumulate on layer “8” whenever separation is needed.

6) Text about utility elevations will accumulate on layer “9” of each particular utility file. (CM9, DU9, EL9, etc…) Depth info still resides in the layer of its item group. (TUNNEL.dwg has the only exception to this, since depth info also goes to layer TU9)

7) Only useful fittings are to be maintained. This includes water tees, water cross connectors, drop downs, *all* reducers, and *all* plugs & caps. (but *NOT* elbows or storm / sanitary wyes)

8) GRX4, GRX5… BU7X2, BU8X5… WAX2, WAX4… are layers created (only as needed) to retain “w-blocked” layer info for specific (project) areas of concern. These temporary layers are *always* left frozen whenever kept on F-Drive. They can be thawed to reference existing conditions (pre-construction) while the same area is being updated using the standard archive layers. Handling project areas this way will apply to any and all GR, BU, or any utility layer affected, but only a commonly needed example “GRX layer” is listed amongst the layers shown on the following pages. These layers are intended for temporary reference use only, and updated info will *not* go on these layers. Instead, any updated info will *always* go to standard layers that have no “X” in the layer name.

9) The *f* shown next to a layer name indicates that particular layer is to be frozen before a plot or and F-Drive update is made.
3.00.00 - DELIVERABLES
DESIGN AND CONSTRUCTION STANDARDS

GROUND.DWG  (White unless otherwise noted)

GR1  General and misc. notes (2’), street names (16’), parking lot (names (8’), lot number circles and related nos. (20’)

GR2  Ground features (linework, related text, retaining walls, some underground features)

GR3  Updated ground within this border (Yellow)

GR4  Outline of updated areas; used only if “ground” and “utilities” have been updated (yellow)

GR5  Minor features like stair steps, fences, grade breaks, curb cut ramps (green)

GR6  Spot shot elevations, surveyed utility paint markers, benchmarks, signs, trees, symbols now only relevant due to their z-value

GRX2  Extra temporary copy of archive existing previous to project (selected project areas only)

Note:  Temporary benchmarks are never to be saved or maintained in any of our archives.

BUILDING.DWG  (Color 30 unless otherwise noted)

BU1  General notes (2’ text)

BU2  UT buildings (underground/overhangs, dashedx2, linetype scale increments of 5, usually 10.0)

BU3  Updated utilities within this border (Yellow)

BU4  Non-UT buildings (white)

BU5  Minor features (green)

BU6  Building Names (white – 8’ text)

BU7  Abbreviations/Numbers (white - 20’ text)

BU8  Section grid lines (white)

BU9  Partially surveyed buildings

BUADDRESS  Street address (white - 8’, with number. parallel to pertinent street)
3.00.00 - DELIVERABLES
DESIGN AND CONSTRUCTION STANDARDS

COMM.DWG  (Magenta)

CM1  General notes (2’ text)
CM2  UT direct burial linework, overhead wires, and symbols, including ECB symbols with comm. conduits (always next to elec.cond.; refer EL2), but add NO NEW guy wires
CM3  Updated utilities within this border (Yellow)
CM4  City direct burial linework, overhead wires, and symbols (cable TV)
CM5  SW Bell direct burial linework, overhead wires, and symbols

DU1  General notes (2’ text)
DU2  UT-vaults and ductbank hatching. UT lids and nos.; ductbank linework with hatching (use linework only for vaults)
DU3  Updated utilities within this border (Yellow)
DU4  City-vault with lids and nos., ductbank linework with hatching / linework only for vaults
DU5  SW Bell-vault with lids and nos., ductbank linework with hatching / linework only for vaults

DU9  Elevation notes (2’ text)

Note: In the somewhat rare occurrence that changes are made to (DU4) City of Austin or (DU5) SW Bell, it will be required to make the identical changes to DUKEY.dwg to reflect those updates on our keymap as well.
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DESIGN AND CONSTRUCTION STANDARDS

**ELECTRIC.DWG** (Magenta)

EL1 General Notes (2’ text)

EL2 UT underground, overhead and abandoned linework and symbols (MH lids, elec.conduit to ECB’s [but emergency call boxes to go CM2 layer], sleeves for future, GUY symbols and wires, but *NO NEW* guy wires)

EL3 Updated utilities within this border (Yellow)

EL4 City linework and symbols (underground, OH, abandoned)

EL9 Elevation notes (2’ text)

Note: Some fountains and irrigation systems are not Utility Department responsibilities. However, we do indicate parts of electric service (i.e. solenoid valves) with no claim of current accuracy/completeness.

**FUELTANK.DWG** (Red)

FU1 General notes (2’ text)

FU2 UT linework and symbols (includes monitoring wells and wires)

FU3 Updated utilities within this border (Yellow)

FU9 Elevation notes (2’ text)

**GAS.DWG** (Red)

GA1 General notes (2’ text)

GA2 UT gas linework and symbols

GA3 Updated utilities within this border (Yellow)

GA4 Southern Union Gas linework and symbols (regulators and meters usually here) vaults, casing under IH35

GA8VLV For gas main valve nos.(Gnnn) (2’ text)

GA9 Elevation notes (2’text)
### SANITARY.DWG (Color 32)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>SA1</td>
<td>General notes (2’text)</td>
</tr>
<tr>
<td>SA2</td>
<td>UT linework and symbols, MH vaults and lids, flow direction arrows, grease trap specialty systems, acid dilution specialty systems (including specialty system MH lids, valves, CO’s, etc…)</td>
</tr>
<tr>
<td>SA3</td>
<td>Updated utilities within this border (Yellow)</td>
</tr>
<tr>
<td>SA4</td>
<td>City linework and symbols (MH vaults and lids, flow direction arrows)</td>
</tr>
<tr>
<td>SA6</td>
<td>UT manhole numbers (3 digit nos.)</td>
</tr>
<tr>
<td>SA7</td>
<td>City manhole numbers (3 digit nos.)</td>
</tr>
<tr>
<td>SA8SEP</td>
<td>Numbering for all grease traps(GTnnn), oil/water separators(OWSnnn), acid dilution basins(ADBnnn), and sand/mud traps(SMTnn) (2’text)</td>
</tr>
<tr>
<td>SA9</td>
<td>Sanitary elevation notes (2’ text)</td>
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### STORM.DWG (Green)

<table>
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<th>Code</th>
<th>Description</th>
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<tr>
<td>ST1</td>
<td>General Notes, UT &amp; city curb inlet boxes (2’text)</td>
</tr>
<tr>
<td>ST2</td>
<td>UT linework and symbols, MH vaults and lids, flow direction arrows, CO’s, headwalls, pond specialty systems (including specialty system MH lids, valves, CO’s)</td>
</tr>
<tr>
<td>ST3</td>
<td>Updated utilities within this border (Yellow)</td>
</tr>
<tr>
<td>ST4</td>
<td>City linework and symbols, MH vaults and lids, flow direction arrows, CO’s</td>
</tr>
<tr>
<td>ST6</td>
<td>UT manhole numbers (4 digit nos.)</td>
</tr>
<tr>
<td>ST7</td>
<td>City manhole numbers (4 digit nos.)</td>
</tr>
<tr>
<td>ST8IN</td>
<td>Curb Inlet numbers, Area Drain numbers, Trench Drains numbers (2’ text)</td>
</tr>
<tr>
<td>ST8OUT</td>
<td>Outfall numbers, 15th St. reference “northing” numbers at bridges (2’ text)</td>
</tr>
<tr>
<td>ST8SEP</td>
<td>Oil/Water Separators numbers (2’ text)</td>
</tr>
<tr>
<td>ST8VLV</td>
<td>Storm valve numbers (2’ text)</td>
</tr>
<tr>
<td>ST9</td>
<td>Storm elevation notes (2’ text)</td>
</tr>
</tbody>
</table>
TU1 General notes (2’ text)

TU2 UT tunnel, expansion chamber and pipe chase linework (all double lined) as well as symbols, MH lids, intake/exhaust vents & access openings, tunnel width/height dimension notes, tunnel gates and retaining walls (See wall thickness notes below)

TU3 Updated utilities within this border (Yellow)

TU4CH Chilled water piping with with related text, sizes, leaders and symbols (drop downs, valves, reducers, plugs).

TU4CT Cooling tower piping with related text, sizes, leaders and symbols (drop downs, valves, reducers, plugs).

TU5 Steam and Condensate Return piping and related related text, sizes, leaders and symbols (drop downs, valves, reducers, plugs).

TU6 Air piping (both instrument and utility) and related related text, sizes, leaders and symbols (drop downs, valves, reducers, plugs).

TU7 Ric-wil (pipe casing) and related text, sizes, leaders and symbols.

TU8CHA Chamber and Station numbers (2’ text)

TU9 Ric-wil elevation notes and tunnel elevation notes. (Also includes Ric-wil & tunnel floor/roof construction depths) (2’ text)

Wall thickness notes:
All tunnel wall lines: offset .67’ from outside wall face, inwardly.
All expansion chamber wall lines: offset 1.0’ from inside wall face, outwardly.
All pipe chase wall lines: offset 1.0’ from inside face of chase wall, outwardly.
3.00.00 - DELIVERABLES
DESIGN AND CONSTRUCTION STANDARDS

WATER.DWG (Blue)

WA1 General Notes (2’ text)
WA2 UT linework and symbols (UT fire lines, fire hydrants, all valves [standard, solenoid and sprinkler], backflow preventors, thrust blocks, vaults)
WA3 Updated utilities within this border (Yellow)
WA4 City linework and symbols (city water meters, fire lines, fire hydrants, valves, thrust blocks, meter vaults)
WA8VLV Water main valve(Wnnn) numbers (2’ text)
WA8HYD Fire Hydrant numbers, both city & UT (2’ text)
WA9 Elevation notes (2’ text)
ENERGY AND ENVIRONMENT

The University has committed to approaching new building construction and major renovations with an emphasis on Life Cycle Cost (LCC). Part of this approach is a focus on maximizing energy efficiency and providing cost effective sustainable design. This approach to energy efficiency and cost effective sustainable design begins at the project conception and continues throughout the construction and operating life of the building. These design standards approach this issue of energy and environment on multiple levels during project design process.

The first goal is that the project meets minimum requirements set by the Energy Conservation Design Standard for New State Buildings, meaning that for the majority of campus facilities (all non-residential facilities) the minimum requirements set forth in current adopted version ASHRAE 90.1 are met, and all supporting documentation is completed and provided for approval in conjunction with the Texas Design Standard Compliance Form as required by the State Energy Conservation Office.

In addition to meeting ASHRAE 90.1, an alternative energy feasibility assessment shall be conducted. This requirement is outlined by Section 2166.403, Title 10, of the Texas Government Code which requires that a governing body undertaking construction of a new state building verify the economic feasibility of incorporating into the building’s design alternative energy devices for space heating and cooling, water heating, electrical loads, and interior lighting. Requirements for this analysis can be obtained from University Staff and the State Energy Conservation Office website and will be completed by the project architect/engineer. Support documentation for this analysis and a letter describing the analysis process should be provided with the submission of the Texas Design Standard Compliance Form.

To further address the issue of energy and environment, the University has established a goal of achieving a minimum “Silver” rating as established in the current adopted version of the LEED (Leadership in Energy and Environmental Design) Green Building Rating System for New Construction and Major Renovations. At times, certification or even adjustments to the level of rating may be required; this will be determined on a project by project basis with the approval of the University. However, as a rule every project is expected to incorporate measures that would allow it to be certified at the “Silver” level. Each project should endeavor to incorporate the maximum number of credits possible within the constraints of the project program and budget.

An effort has been made during the development of the design standards to provide University accepted options to standards in order to obtain various LEED points. Additional options will need to be presented to the University in order to obtain project LEED objectives. The designer should utilize the LEED checklist and work closely with the University to develop a design approach during the programming phase to meet the University LEED objectives established at the beginning of the project. As required, in order to obtain various points, deviation from the requirements outlined in these design standards may be necessary. At a minimum, these deviations must be approved by University Staff in writing. When necessary and at the request of the University, a life cycle cost analysis must be completed to determine the economic viability of obtaining various points. Requirements and guidelines for the life cycle cost analysis are provided with these design standards.
SPECIAL MECHANICAL, ELECTRICAL, AND PLUMBING CONSIDERATIONS WITH LEED CREDITS

When considering which points will be required to obtain University LEED objectives, the designer should be aware of the potential design impacts carried across the major design disciplines. At the time of this revision for these standards, the following list was compiled of potential design issues that may carry over to the Mechanical, Electrical, and Plumbing disciplines and is based on the potential LEED credit categories defined in LEED-NC version 2.2. While these issues may not apply to all projects and there are obviously more coordination and design issues involved with a LEED design, the following list is provided to spur awareness of design elements and coordination effort that may be required. In addition, the following list is not intended to limit the designer’s responsibility or creativity in providing a successful and functional LEED design.

SUSTAINABLE SITES

Credit 4.2 – Alternate Transportation: Bicycle Storage & Changing Rooms:
1) Consider need for area drains and lighting for bicycle storage areas/racks.
2) Consider special requirements for changing rooms:
   a. Showers
   b. Lavatories, urinals, water closets,
   c. Domestic water heater,
   d. Toilet room and shower exhaust

Credit 6.1 – Stormwater Design: Quantity Design
1) Consider stormwater collection for non-potable uses
   a. Landscape irrigation, flushing urinals and/or toilets, cooling tower makeup (incorporate with existing fin water recovery system).
2) Consider volume of water collection and storage location
3) If multiple tanks are utilized, special consideration of the following will be required:
   a. Inlet pipe size,
   b. Tank arrangement,
   c. Pipe materials,
   d. Tank equalization
   e. Access for cleaning
4) Consider required treatment:
   a. Settling area to remove heavy solids
   b. Cyclone filters to remove lighter solids
   c. UV lights to prevent bacterial growth.

Credit 7.2 – Heat Island Effect: Roof
1) Coordinate with project Architect to establish roof requirements. Material/product selection should be accounted for in load and energy models. Material/product selection may place limitations on equipment locations and roof penetrations.

Credit 8 – Light Pollution Reduction
1) Consider public safety requirements
2) Consider requirements for unexpected lighting fixture layouts in perimeter areas within the building
3) Lighting layout within the building may affect layout of air distribution
WATER EFFICIENCY

Credit 1.1 – Water Efficient Landscaping: Reduce by 50%
1) Coordinate with Landscape Architect to verify water quantities (impact to water service)
2) Consider use of captured rainwater or gray water

Credit 1.2 – Water Efficient Landscaping: No Potable Water Use or No Irrigation
1) Coordinate with Landscape Architect to verify water quantities (impact to water service)
2) Captured rainwater system will be required, potentially great volume that established by Credit 1.1.
3) Consider impact to storm water collection system
4) May require other “recycled” water sources

Credit 2 – Innovative Wastewater Technologies
1) Consider use of high efficiency fixtures
2) Consider use of “recycled” water sources—fin (condensate water), lav and shower drainage (onsite greywater)
   a. Consideration of treatment, storage, and separate waste piping.

Credit 3.1 – Water Use Reduction: 20% Reduction
1) Integralely related to Credit 2
2) Should be obtainable with high efficiency fixtures

Credit 3.2 – Water Use Reduction: 30% Reduction
1) Integralely related to Credit 2
2) Will typically require more than just high efficiency fixtures

ENERGY & ATMOSPHERE

Prerequisite 1 – Fundamental Commissioning of the Building Energy Systems
1) Coordinate closely with the Commissioning Agent
2) Commissioning Agent will require assistance with developing the Basis of Design Document
3) The Commissioning Agent will provide specifications to incorporate in the Construction Documents and will be involved in design reviews.

Prerequisite 2 – Minimum Energy Performance
1) Must comply with both mandatory and the prescriptive requirements of ASHRAE 90.1
2) Proof of compliance will be based on data output from LEED approved computer load/energy estimating programs only

Prerequisite 3 – Fundamental Refrigerant Management
1) No use of CFC refrigerants

Credit 1 – Optimize Energy Performance
1) 20 % Improvement in building performance beyond ASHRAE 90.1 requirement is the preferred minimum level for new University facilities
2) Additional improvements may be required based on LEED objectives.
Credit 2 – Onsite Renewable Energy
1) Consider impact to electrical distribution/service
2) Consider impacts to mechanical systems
3) Consider impacts to roofing system (e.g. installation of solar heat collectors)

Credit 3 – Enhances Commissioning
1) Coordination required for additional design document reviews by Commissioning Agent
2) Coordination required for additional reviews by Commissioning Agent of submittals, RFI’s, change orders
3) Commissioning Agent may also require assistance with development of a Systems Manual.

Credit 4 – Enhanced Refrigerant Management
1) Select refrigerants that do not deplete ozone or increase global warming
2) Perform maximum threshold calculation

MATERIALS & RESOURCES

Prerequisite 1 – Storage & Collection of Recyclables
1) Specialized equipment may be implements such as crushers/compactors, consider requirements for water and waste services for area washdown and power requirements.

Credit 4 – Recycled Content & Credit 6 – Rapidly Renewable Materials
1) Material U-values may not be readily available
2) Consult with University prior to incorporating organic insulation materials for approval. Treatment and prevention of mold growth in and on organic insulating materials will need to be provided.

INDOOR ENVIRONMENTAL QUALITY

Prerequisite 1 – Minimum IAQ Performance
1) ASHRAE 62.1 minimum requirements must be met.
2) Requires system percentage of outside air high enough to meet requirements of the “critical” zone.

Credit 1 – Outdoor Air Delivery Monitoring
1) Requires direct measurement of outdoor air quantities serving non-densely populated spaces, AND requires monitoring of CO2 concentrations within densely populated spaces.
2) Control system must be capable of taking corrective action when necessary.

Credit 2 – Increase Ventilation
1) Requires 30% more outside air compared to ASHRAE 62.1 minimums.
2) Consider impact to energy savings (and E&A Credit 1) before implementation of this measure.

Credit 3.1 – Construction IAQ Management Plan: During Construction
1) Will required specification revision compared to standard projects to direct the contractor regarding specific construction practice:
   a. Proper storage and packaging of absorptive MEP materials
   b. Sealing duct systems during construction
c. Utilizing MERV 8 filters on AHU’s during construction

Credit 3.2 – Construction IAQ Management Plan: Before Occupancy
1) Requires flush of building (14,000 cf per sf), or baseline air testing
2) HVAC system must be designed to accomplish the flushing (via air economizer cycle)
3) Either flushing or air testing requires schedule time for the contractor

Credit 4.1 – Low-Emitting Materials: Adhesives & Sealants
1) Consider use of alternate adhesive & sealant products for items such as ductwork, insulation, pipe dope, etc.

Credit 4.2 – Low-Emitting Materials: Paints & Coatings
1) Consider alternates for paints and coating utilized with mechanical and electrical equipment, piping, insulation, etc.

Credit 5 – Indoor Chemical & Pollutant Source Control
1) Requires isolation of pollutant rooms: laundry rooms, janitor’s closets, printer rooms, etc.
   a. Negative pressure (exhaust) will be required in such spaces
   b. Will required printers to be in dedicated rooms
2) MERV 13 filters will be required

Credit 6.1 – Controllability of Systems: Lighting
1) Consider special requirements for controllability for all shared multi-occupant spaces
2) HVAC zoning coordination required for commonality of control interface locations
   (alignment of HVAC zones with lighting zones preferred).

Credit 6.2 – Controllability of Systems: Thermal Comfort
1) Requires individual HVAC controls for minimum of 50% of the occupants
   a. Consider impact to HVAC system zoning (e.g. terminal box placement for VAV systems)
   b. Credit will difficult to achieve for most campus facilities

Credit 7.1 – Thermal Comfort: Design
1) Meet requirements of ASHRAE 55 Thermal Comfort Conditions for Human occupancy and demonstrate design compliance

Credit 7.2 – Thermal Comfort: Verification
1) Building comfort must be assess over time
2) Requires a survey over time and corrective action if great than 20% of the occupants are dissatisfied

Credit 8.1 – Daylight & Views: Daylight 75% of Spaces & Credit 8.2 – Daylight & Views: Views for 90% of Spaces
1) Will required coordination with HVAC air distribution layout, light fixture placement and lighting controls.
CODES, STANDARDS, AND REGULATIONS

No portion of these design standards may be reproduced in any specification intended to be a part of construction documents without the prior written permission of The University of Texas at Austin Campus Planning and Facilities Management. Any such written permission shall specifically refer to the requirements of this section.

The University of Texas at Austin uses as a basis of design the requirements of all applicable building, fire, zoning, accessibility standards and labor codes and industry standard manuals of practice, including but not limited to the following:

- The Texas Engineering Practice Act and the Texas Board of Professional Engineers Rules
- The Architects' Registration Law and the Texas Board of Architectural Examiners Rules and Regulations
- Texas Government Code
- Texas Health Asbestos Protection Act and Texas Asbestos Health Protection Rules
- Fire Prevention Code: the University of Texas at Austin handbook of Operation Procedures, Chapter 10.
- National Fire Protection Codes
- NFPA 101, Life Safety
- OSHA Standards
- The University of Texas at Austin Storm Water Management Program (revised June 1, 2000
- International Building Code
- Texas Accessibility Standards and the Americans with Disabilities Act (ADA)
- Energy Conservation Design Standard for New State Buildings
- ASHRAE 90.1 as adopted by the State Energy Conservation Office
- ANSI Z9.5 – Laboratory Ventilation
- ANSI B31.1 – Power Piping
- ANSI B31.9 – Building Services Piping
- Leadership in Energy & Environmental Design (LEED) Green Building Rating System for New Construction and Major Renovations
- Labs21®
- National Electric Code
- Uniform Plumbing Code (City of Austin)
- International Mechanical Code
- International Plumbing Code
- International Fuel Gas Code
- ASHRAE Handbooks
- SMACNA Handbook
- American Concrete Institute (ACI)
- American society for Testing and Materials (ASTM)
- CRSI Handbook of Recommended Practice for placing reinforcing bars, bar supports, specification and nomenclature
- National Ready-Mixed Concrete Association Publication: Concrete Plant Standards and Truck Mixer and Agitator Standards
4.01.02 – CODES, STANDARDS, AND REGULATIONS
DESIGN AND CONSTRUCTION STANDARDS

- Texas Standard Specifications for Construction of Highways, Streets and Bridges: Texas State Department of Highways and Public Transportation
- The University of Texas at Austin Fire Protection Construction Standards

All concept or design submittals shall address fire protection and life safety criteria and shall be submitted as separate analyses. The following fire protection engineering provisions, where applicable to the project shall be included in this analysis. NFPA standard 170, fire safety symbols shall be used for Architectural and Engineering drawings. Areas for analysis are as follows:

a. Type of construction;
b. Classification of occupancy;
c. Building separation or exposure protection;
d. Location of all fire rated walls including fire rated doors, and fire dampers with identification as applicable (include fire walls, fire partitions, smoke compartments);
e. Life safety provisions (exit travel distances, exit widths based on capacity and occupant load, number of exits, exit signs, emergency lighting and secondary power requirements);
f. Automatic extinguishing systems (identification of all sprinkled areas and other areas protected by specialized suppression systems);
g. Smoke/Control management systems, dampers, and smoke partitions. The smoke control system shall be identified by schematic diagram, where applicable, that indicates the operation of the normal HVAC mode and the smoke removal mode;
h. Fire alarm system (type of alarm system and location of the fire alarm equipment with fire zones);
i. Fire detection system (type of detection system and location of detectors with fire zones);
j. Location of fire extinguisher cabinets and standpipes/hose cabinets.

In all cases, the University shall use the most current published edition. It is the responsibility of the design professional to develop the construction documents in compliance with all applicable codes, statutes and regulations. The Texas State Fire Marshal is the authority having jurisdiction over University projects. Where an applicable code, statute or regulation addresses the requirements set forth in these standards, the most stringent requirement shall be included in the construction documents. If any requirement of these standards is deemed to be in conflict with applicable codes, statutes, regulations or other UT standards, immediately notify in writing UT project representative.

Nothing in these standards is intended to be specific to the conditions of any particular project. It is the design professional’s responsibility and liability to determine that the specific project requirements have been included within the design and the construction documents. The design professional is liable to the extent provided by law for all design decisions regarding any specific project and neither these standards, the review by University representatives, nor the approval of the design by the University shall constitute a waiver or disclaimer of liability of the design professional.

It is the responsibility of the design professional to ensure that the standards are followed in the development of the design and the preparation of the documents. During the construction phase, it is the responsibility of the contractor and University construction personnel to ensure that the facility is built in accordance with the documents and these Standards. If there is to be a variance to using a Standard on a project during the design phase(s), it is the responsibility of the designer to bring it to the attention of the UT Project Representative in writing. If such a variance is proposed during the construction phase, it is
the responsibility of the contractor or University construction personnel to bring it to the attention of the UT Project Representative in writing.
CAMPUS CONDITIONS

Campus “design” conditions will vary between The University of Texas at Austin campuses; however, the following list of conditions is provided for the Main Campus. Even within the Main Campus, the following are considered typical design conditions and will vary based on specific project location and utility availability. The designer should establish actual conditions with the University at the beginning of each project including potential utility tie-in locations and requirements.

- **Chilled Water Supply Temperature:** 42 degrees F
- **Chilled Water Return Temperature:** 58 degrees F
- **Chilled Water Supply Pressure:** Varies based on project location; however, building pump should be sized to handle the full pressure requirement of the building.

- **Steam Condition:** 170 psi, 500 degrees F
- **Pumped Condensate Pressure:** 20 psi
- **Recovered Water Pressure:** 35 psi
- **Domestic Water Pressure:** Varies based on project location
- **Purified Water Pressure:** Varies based on project location
- **Fire Protection Water Pressure:** Varies based on project location; zone dependant
- **Compressed Air:** 100 psi
- **Electric Service:** 12,000 volts and 4160 volts, 3 phase; contact University staff for conductor size

**Outdoor design conditions:**
- Winter = 20°F (ASHRAE Extreme Min. Mean)
- Summer = 98°F DB / 74°F WB (ASHRAE 0.4%)
- Dehumidification = 89°F DB / 78°F WB (ASHRAE 0.4%)

Note: Applications with 50% outside air or greater shall verify system performance at dehumidification condition.

**Indoor design conditions:**
- Winter = 68°F +/- 2°F
- Summer = 75°F +/- 2°F
- Relative Humidity = 50% +10% / -20%

Note: Specialized spaces, such as IT rooms, may be subject to different design conditions. Coordinate with project requirements.
PART 1: GENERAL

1.01 General Requirements

A. These guidelines are intended to provide a framework to evaluate building projects for the University of Texas at Austin to:
   1. Verify the feasibility of options which deviate from the guidelines provided elsewhere within the Design Standards.
   2. Establish project budgetary costs and energy impact.

B. Designers wishing to provide non-standard solutions for building projects which may provide better value or superior sustainability features over construction projects defined by the design standards are encouraged to follow these guidelines for justification. The design team must notify the UT project manager of intent to provide an alternative solution to baseline design types identified within the design standards at the onset of the project. This notification should take place early in the project will during the Pre-Schematic Design Phase. If required, additional alternates may be investigated during the Schematic Design phases.

C. After the design approach is approved, development of budgetary costs including construction budget, annual operating budgets impacts to campus utilities will be required.

D. All projects will require the completion of the Energy Impact Statement; refer to the appendix for instructions and format.

1.02 Methodology:

A. General

The following process will be incorporated into the design plan for project teams which seek to incorporate alternative building systems into their designs and to assist in establishing project budgetary costs and energy impact. This process will ensure that the proposed project will provide the best value to the University. Best value will be determined on the basis of a weighted scoring system which will include the results of Life Cycle Cost (LCC) analyses and, as required, the qualitative benefits of sustainable design.

B. Definitions

1. Design Team – Third party designers or design/builders retained by the University to design building or building systems.
2. UT Project Team – Team of individuals employed by the University charged with oversight and steering of the project to ensure compliance with goals of the University.

3. Project Team – Members of both the Design and UT Project Teams.

C. Schedule / Milestones

1. Project Evaluation Workshop

During the Pre-Schematic Design phases, the Project Team will hold a Project Evaluation Workshop. The intent of this workshop is for the Design Team to identify any proposed alternates to the Design Standards and establish Project Sustainability Goals. Once identified, the team will then identify the method(s) of LCC analysis, the social and environmental impacts of the alternate(s), and confirm project parameters and data, including information requested from the University.

2. Project Design Evaluation

Evaluation alternates will be completed during the Schematic Design phase by the Design Team.

2. Project Evaluation Reviews

During the Schematic Design phase, the Project Team will meet to review the initial findings of the LCC analysis. The Design Team will present a comparison of alternatives to the baseline project, as defined by the Design Standards. The purpose of the review is to enable the Project Team to make decisions based on the Project Sustainability Goals. At this time, the UT Project Team will be given an opportunity to identify sensitivity criteria to investigate for the next review. This process will be repeated at least once more, at the discretion of the UT Design Team, before the conclusion of Design Development.

D. Project Evaluation Comparative Studies

1. Procedural Guidelines

The primary method of Project Evaluation Comparative Studies (PECS) will be a comparison between two or more alternatives for each of the topics identified for study during the Project Evaluation Workshop. The alternatives should be viable options under consideration for the project.

The PECS will be formally documented and reviewed twice during the design process, during the Schematic Design and Design Development
phases. However, the principles and knowledge gained by these studies are applicable at any stage in the design process. The Project Team will work together in the preliminary design stages to lay out the schedule and study categories to maximize the value of these studies for each specific project.

3. Study Categories

The following building systems shall serve as the basis for the selection of the comparative studies:
1. Energy Systems
2. Electrical Systems
3. Building Envelope
4. Siting / Massing Strategies
5. Structural Systems
6. Mechanical Systems
7. Water Systems
8. Interior Systems

Certain study categories may be more relevant to particular building types or projects and project-specific priorities will be established at the initial Project Evaluation Workshop in the Pre-Schematic Design phase. However, the above study categories/ building systems do not operate in isolation. The energy and life cycle cost models shall be developed with an understanding and acknowledgement of the inter-relationship of building systems. For example, this fact is very critical when evaluating issues such as quantity, capacity, and placement of air handling equipment.

E. Development of Annual Operating Budget

Following the Final Selection and Design Approval Process, a budget for the ongoing operations of the selected facility must be established by the design team. This budget will contain many of the components of the life cycle evaluation (discussed in greater detail in subsequent sub-sections of this Standard). These costs include:

- Operations and maintenance costs
- Energy costs
- Water / wastewater costs

The capture of these costs at the onset of the construction project will provide the University with a mechanism for budget planning.

F. Documentation
The following is a summary of documentation requirements for the Project Evaluation Process:

1. Record of Project Sustainability Goals from the Project Evaluation Workshop, including benchmarking objectives and metrics. Include in the project Scoping, Programming or Feasibility Study Report as required.

2. Record of project evaluation criteria to be evaluated, including social and environmental impacts, project parameters and data. Include in the project Scoping, Programming or Feasibility Study Report as required.

3. Record of largest energy impacts & priorities based on preliminary energy model in conjunction with the MEP Design Intent document.

4. Record of the initial LCC results in conjunction with the MEP Design Intent document submitted at the conclusion of Schematic Design. Refer to the Appendix for the LCC analysis template.

5. Updated project budget and schedule with justified elements incorporated.

6. Record of the refined LCC results in conjunction with the MEP Basis of Design document submitted at the conclusion of Design Development.

7. Final energy model report. Refer to Section 2.04 for contents of report.

8. Provide a projected Annual Operating Budget, Energy Impact Statement, and Initial Construction Budget for the project.

PART 2: LIFE CYCLE COST EVALUATION

2.01 Life Cycle Cost Evaluation

A. General

The Life Cycle Cost (LCC) process will be used to:
1. Evaluate project alternates.
2. Establish budgets for the final approved project.

The LCC process of evaluating project alternatives is a differential analysis. For portions of a project which are common to all alternatives (e.g. the shell of the building in an evaluation of different HVAC systems) it is not necessary to include cost estimates or operations and maintenance estimates for those portions which are common. Because this analysis is differential it is important to remember that the specific LCC value of each alternative are not specifically meaningful (operating budgets should not be based solely on these results) but rather only the differential between alternatives is important.
Once design alternates are chosen, new budgets considering the entire project scope must be developed. The methods below will also be utilized to establish these new budgets.

Refer to the Appendix for the LCC template.

2.02 Construction Cost Projection

A. Option 1 – Constructor’s Budget Estimate (Preferred)

For projects which are to be constructed by design-build teams, CM at risk teams, or CSP teams, provide actual working budget estimates for the construction of proposed alternatives. A budget for the baseline system must also be provided for inclusion in the baseline LCC model.

B. Option 2 – Engineer’s Opinion of Probable Cost

For design-bid-build projects, this option will be compiled using a combination of vendor quotes and published cost sources. Vendor quotes are preferred for major equipment purchases. If utilized, Project Team must ensure appropriate markups for contractor purchasing, handling and profit are added to equipment quotes to ensure true market conditions are reflected.

A published cost source for construction specific pricing such as RS Means Construction Cost Data books should be used to compile the estimate for the balance of the project. Ensure markups for overhead and profit as well as the city cost index for Austin, Texas are included in the compiled estimates.

C. Contingency

A 30% contingency factor should be applied to each alternative being studied since this estimate is being prepared in advance of the more refined design stages. This contingency should be included regardless of whether the estimate is generated by the contractor or the A/E.

D. Financial Terms

Construction cost inflation rate:.................. 3.0% annually
Term of financing: ................................................ 25 years
Finance rate:................................................ 6.0% annually

The engineer’s opinion of probable cost shall also include appropriate cost for design, construction administration, and commissioning as based on a percentage of construction cost, as directed by the University.
E. Documentation

The engineer’s opinion of probable cost shall be provided in sufficient detail such that costs for each CSI MasterFormat™ (2004 Edition) division are identified. Backup documentation, such as vendor quotes or contractor estimates shall be provided upon request of the University.

Consider impacts to all building components or systems. For example, be sure to capture cost savings for reductions in building footprint due to consolidation of mechanical spaces.

2.03 Operations and Maintenance

A. General

As it pertains to LCC development, operations and maintenance (O&M) costs encompass all costs of ownership outside of initial construction cost and energy, water, or wastewater consumption costs. Custodial costs, the cost of consumables (e.g. air filters, lubricating oil, etc.), and corrective repairs would all be considered to be O&M.

B. Option 1 – Vendor Quote (Preferred)

To implement this option, the Design Team would solicit quotes for annual service contracts from 3rd party maintenance providers in the Austin area. Quotes must be obtained for each of the systems to be analyzed (including the baseline system) from the same vendor to ensure an apples-to-apples comparison. The annual service contract quote should be for an all-inclusive service plan which includes regular service visits for preventative maintenance as well as inclusion of replacement parts and consumables.

C. Option 2 – Published Maintenance Cost

In lieu of soliciting quotes for maintenance contracts, the Design Team can develop O&M costs using a published cost sources such as the RS Means Maintenance and Repair Cost Data or the Whitestone Research Building Maintenance and Repair Cost Reference. Each volume is a comprehensive source of building maintenance and repair cost statistics.

These references define the cost to maintain a building and its systems over its service life. They also provide the average lifetime of a specific building components. Each volume provides detailed O&M cost information, including regional cost indexes to tailor cost information to the Austin area.

D. O&M Cost Types
1. Annually Recurring Maintenance Costs

These costs are also sometimes referred to as cyclical costs. Most vendor quotes or published sources will provide costs as annual values. Added facility personnel costs resulting from new equipment would be included in this category. Proposed long-term maintenance service agreements and extended warranty costs can be annualized and also added to the baseline annual operations & maintenance costs.

2. Non-annually recurring maintenance costs

As the name implies, these costs are not incurred each year, but when they do occur they may be substantial. An example of such a cost would be replacement of a building system component at a discrete time during the analysis period.

E. Financial Terms

O&M escalation rate: 3.0% annually

F. Documentation

Backup documentation, such as vendor quotes or contractor estimates shall be provided upon request of the University.

2.04 Energy Projections

A. General

Energy modeling is a prerequisite to conducting the Life Cycle Cost analysis component of the comparative studies. A preliminary energy model will be developed in the Schematic Design phase in order to identify and document the largest energy impacts of the project. This energy model will also serve as the platform from which to analyze energy consumption rates of the alternate options in both the Schematic and Design Development phases. The energy model will continue to be refined throughout the design phases. A final run of the model incorporating the selected alternative design elements will be performed and documented prior to the conclusion of Construction Documentation phase to establish the annual energy budget. Energy projections must be developed using an energy simulation program.

B. Software Requirements

The simulation program shall be a computer-based program for the analysis of energy consumption in buildings. The simulation program shall include calculation methodologies for the building components being modeled. The
simulation program shall be approved by the University and shall, at a minimum, have the ability to explicitly model all of the following:

- A minimum of 1400 hours per year
- Hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points, and HVAC system operation, defined separately for each day of the week and holidays
- Thermal mass effects
- Ten or more thermal zones
- Part-load performance curves for mechanical equipment
- Capacity and efficiency correction curves for mechanical heating and cooling equipment
- Air-side and water-side economizers with integrated control

In addition, the simulation program shall have the ability to either directly determine the design energy cost and energy cost budget OR produce hourly reports of energy use by energy source suitable for determining the design energy cost and energy cost budget using a separate calculation engine.

The simulation program shall also be capable of performing design load calculations to determine required HVAC equipment capacities and air and water flow rates. The simulation program shall also be tested according to ASHRAE Standard 140 and the results shall be furnished by the software provider.

C. Results

The simulation will be used to determine the utility consumption and demand of the facility. These will then be input into the LCC model to determine the relative energy costs for each alternative.

D. Financial Terms

Baseline steam cost: ........................................... $11.71 per klb
Baseline chilled water cost: .......................$0.1065 per tonhr
Baseline electric cost: ..............................$77.00 per MWh

Verify the values listed above are currently applicable with the UT Project Team before commencement of LCC analysis.

The University of Texas at Austin produces all of its own electricity via combustion and steam driven turbines. Fuel gas (natural gas) is the only imported energy commodity to the campus. Since natural gas ultimately drives the production of all energy commodities distributed on campus, the projected escalation in its cost is used to calculate prices for energy consumption.
To project the cost of natural gas, the U.S. Department of Energy (DOE) Energy Information Administration (EIA) publishes energy cost escalation indices to project future fuel and electricity costs. These indices are regionally specific for industrial, commercial, or residential customers and updated annually. They are published in the Energy Price Indices and Discount Factors for Life Cycle Cost Analysis - April 2007, Annual Supplement to Handbook 135. The factors are calculated with the latest Federal Energy Management Program (FEMP) discount factors.

Table 2.04.D – Projected escalation rates for natural gas in Texas (industrial) as of April 2007.

<table>
<thead>
<tr>
<th>Year</th>
<th>Escalation Index</th>
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<tbody>
<tr>
<td>2008</td>
<td>-5.18%</td>
</tr>
<tr>
<td>2009</td>
<td>-4.28%</td>
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<td>2010</td>
<td>-5.52%</td>
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<tr>
<td>2011</td>
<td>-2.47%</td>
</tr>
<tr>
<td>2012</td>
<td>-0.76%</td>
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<tr>
<td>2013</td>
<td>1.31%</td>
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<tr>
<td>2014</td>
<td>1.31%</td>
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<tr>
<td>2015</td>
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<tr>
<td>2016</td>
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<td>3.22%</td>
</tr>
<tr>
<td>2032</td>
<td>3.20%</td>
</tr>
</tbody>
</table>

E. Documentation - Energy Model Report

The Energy Model report shall contain, as a minimum, the following pieces of information:

- Inputs:
  - Room/zone design parameters
4.02.00 – PROJECT DESIGN EVALUATION AND APPROVAL PROCESS
DESIGN AND CONSTRUCTION STANDARD

- Equipment design parameters
  - Output:
    - Hourly reports of energy use by energy source
  - Depending on the nature of the project, additional reports may also be requested by the University.

This information shall be presented as output from the computer program used for the analysis. If requested by the University, electronic files of the simulation models shall be provided.

2.05 Water / Wastewater Projections

A. General

Water and wastewater consumption can be omitted from the LCC analysis if it is deemed that the alternatives being studied will not appreciably differ from that of the baseline building. Gain approval from the UT project manager before omitting from analysis.

If water and waste water cost implications are to be included in the analysis, calculations must be provided to the UT project team to projected savings.

B. Financial Terms

Water rate: $2.77 per 1000 gallons
Wastewater rate: $4.49 per 1000 gallons
Water/wastewater escalation rate: 3.0% annually

2.06 General Economic Conditions of Analysis

A. General

The following financial terms shall be used in the LCC analysis for projects on the UT Austin Campus:

Discount rate: 6.0% annually
General inflation rate: 3.0% annually

2.07 Sensitivity Analysis

A. General

If desired by the University, the design team may be asked to provide additional life cycle calculations to determine the winning option’s sensitivity to changing...
economic factors. This is done to judge the potential risk of implementing a construction alternative.

B. Sensitivity Variables

Variables commonly adjusted for sensitivity analysis:

- Increase and/or decrease in discount rate
- Increase and/or decrease in inflation rates (capital cost, O&M, water/wastewater)
- Increase and/or decrease in construction costs (as a percentage)
- Increase and/or decrease in finance rate
- Increase and/or decrease in O&M costs (as a percentage)
- Increase and/or decrease in energy cost rates
- Increase and/or decrease in water/wastewater cost rates
- Or other, as defined by UT project manager

The UT project manager will specify what sensitivity analyses shall be run. The need for sensitivity analysis may not be apparent until after the baseline LCC results have been published.

PART 3: EVALUATION OF QUALITATIVE FACTORS

3.01 Evaluation of Qualitative Factors

A. General

LCC analysis does not directly address the social and environmental life-cycle impacts of design alternatives. These costs and benefits should be presented and evaluated in conjunction with the results of the LCC analysis. While tools (such as the USGBC’s LEED certification program) are available to assist the Project Team in conducting this analysis, it is ultimately up to the Project Team to determine the method of assessment most compatible with project objectives.

B. Sustainability Considerations

Below is a list of considerations for social and environmental impact assessment. This list is not intended to be all-inclusive, but to highlight anticipated issues to spur discussion:

Land Use, Water and Ecosystem Quality

- Retain open space
- Optimize program and development density
  - Reduce site disturbance
  - Reduce building footprint
- Increase flexibility / adaptive reuse potential
Optimize building orientation
  - Utilize passive design strategies
  - Employ natural ventilation strategies
Reduce heat island effects
  - Provide adequate shade coverage
  - Select high albedo / light-colored materials
  - Select high-reflectance, high-emissivity roofing materials
Reduce automobile use
Promote efficient transportation alternatives
Optimize parking lot location and design
Maximize water use efficiency
  - Reduce potable water use
  - Use captured or recycled water
  - Employ sustainable landscaping strategies
Minimize stormwater runoff
  - Select permeable paving materials
Increase on-site stormwater filtration
Reduce stormwater contaminants
Employ restorative design strategies

Social & Programmatic Factors
- Improve building safety and security
- Improve site security
- Improve interior acoustic control
- Reduce exterior noise pollution
- Reduce exterior light pollution
- Improve operational efficiency
- Provide flexibility of systems

Materials and waste
- Reduce solid waste generation
  - Promote existing building reuse
  - Select reused and salvaged materials
  - Select recycled content materials
  - Reduce non-renewable resource selection
  - Maximize storage/ collection of recyclables
- Select rapidly renewable resource materials
- Select low-embodied energy materials

Indoor Environmental Quality
- Optimize ventilation effectiveness
- Employ natural ventilation strategies
- Minimize indoor and chemical pollutants
  - Select low-emitting materials
  - Encourage non-toxic maintenance protocols
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   o Design separation from exterior pollutants
     • Provide carbon dioxide monitoring
     • Improve acoustic environment
     • Enforce construction IAQ management
     • Provide facility in-use IAQ management plan
     • Increase thermal comfort
     • Improve controllability of systems
     • Optimize natural daylight & views

Energy and Atmosphere
   • Reduce fossil fuel depletion
   • Use renewable energy sources
   • Reduce energy-related emissions
     o Reduce greenhouse gas emissions
     o Reduce ozone-depleting emissions
     o Maximize envelope thermal performance
     o Integrate daylight/electric lighting controls
     o Improve mechanical systems performance
     o Eliminate equipment use of CFC’s

C. Other Considerations
   • Architectural (signature) features
   • Adaptability of building for future uses
   • Demonstrated experience providing value to UT Austin or other institutions of higher education
   • Other factors, as agreed upon by the Project Team

PART 4: PROCESS FOR FINAL SELECTION AND DESIGN APPROVAL

4.01 Process for Final Selection and Design Approval

A. General

   Once the LCCs have been compiled and the applicable qualitative factors accounted for, a scoring system shall be utilized to determine the best solution for the University. Because each project is different, and the objective of each facility varies, a simple weighting process cannot be established for all projects.

   The Design Team must work closely with the UT Project Team to develop an appropriate framework of evaluation for each project.

B. Point System
LCC analysis results shall be presented in conjunction with social and environmental impacts to facilitate decision-making. A point system, developed by the Project Team during the Project Evaluation Workshop, shall be utilized for the final evaluation. Points may be awarded as needed for a given project type, for example a project such as an alumni visitor center may be carry more architectural significance than a typical building. In this case, the LCC cost results may only count for 30% of the total design score, whereas aesthetic/sustainable features may compose the other 70% of the score.

END OF STANDARD
PART 1: GENERAL

1.01 General Requirements

A. This section of the design and construction standard outlines general requirements for designs to be performed for the University of Texas at Austin. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section and the ones that follow so that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

B. Every effort shall be made during design to ensure that the systems meet the following criteria:
   1. The systems shall be safe.
   2. The systems shall be reliable.
   3. The systems shall be maintainable.
   4. The systems shall be energy efficient.
   5. The systems shall be sustainable.

1.02 General Building Criteria

A. General
   1. Layout building structure and space utilization to preserve dedicated straight avenues for large duct runs at locations separate from electric runs and plumbing runs. On buildings which may in the future be used for scientific research, provide organized space for future ductwork in the ceilings and chases.

   2. New structures shall be designed so that penetrations may be made throughout except at structural components such as beams, or webs at pan joists, etc. This will allow maximum flexibility for future unforeseen uses and requirements for the building.

   3. Structural components shall in general be of uniform depth throughout a floor, allowing maximum space for routing of ducts, pipes, etc. above ceiling.

   4. Frame in the building chase with a ring beam above, not below, the floor to minimize bottlenecking the air ducts and to minimize floor-to-floor spacing. Include open steel grating at each floor inside chases.

   5. The contractor will hire a Registered Professional Land Surveyor to replace all campus control brass monuments that are destroyed or altered as a result of the project. Information regarding existing UT-Austin campus control monuments, Texas State Plane Survey Network, may be obtained from Bobby Rigney with Space Information Management Department, (512-471-1600).

   6. Paint a bright stripe on the treads of machine-room steps, to benefit workers with limited sight. Add visually-contrasting nosing to steps, particularly steps made of exposed aggregate.

   7. Protect stair treads during remodel projects, and repair or replace any damaged.

   8. Coat floors of mechanical rooms. Coating selected shall remain pliant to span structural settling cracks and shall produce a seamless membrane resistant to puncture or damage. Floor coating shall extend up perimeter walls and floor penetrations a minimum of 12 inches. Exterior of tunnel walls and floors shall be sealed and drained in accordance with standard subsurface exterior structural building walls. Coating system shall consist of 2 coats with a non-slip abrasive applied between first and second coat.

END OF STANDARD
01 00 00 GENERAL REQUIREMENTS

1. These Design and Construction Standards are maintained online at the UT Austin Project Management and Construction Services website, and are dated. Prior to beginning work on a project, verify you are using the most current edition.

2. Requirements for work may also be included in other University contract documents, including but not limited to the following. Coordinate with the UT Project Manager to gain access to these files as required.
   A. Vendor’s contract with UT Austin.
   B. 2005 Uniform General and Supplementary General Conditions for University of Texas System Building Construction Contracts, current version adopted by UT Austin.
   C. UT Austin Additional General Conditions.
   D. UT Austin Special Conditions (varies project to project; coordinate with the UT Project Manager).
   E. UT Construction Safety Program.

2. Work on the main Austin campus must adhere to the principles and guidelines established in the approved UT Austin Campus Master Plan.

3. The University promotes energy efficient sustainable design, construction and building operations. Design practices, materials specified and construction activities must follow the UT Austin Sustainability Policy and the United States Green Building Council's LEED (Leadership in Energy and Environmental Design) Green Building Rating System®, unless otherwise approved by the UT Project Manager.

4. The University implements a variety of project types, ranging from highly complex new construction to small interior renovation projects. Not all information provided here will apply to each project, depending on the specifics of the individual project. Coordinate questions regarding applicability of certain information in these Standards with the assigned UT Project Manager.

01 10 00 SUMMARY

01 11 00 SUMMARY OF THE WORK

01 11 13 Work Covered By Contract Documents

1. A general description of all elements of the project, including exterior work and any other related work, is required. This description, though brief, should be complete enough to indicate the full scope of work in each contract so that the prospective bidders can decide whether or not they wish to bid on the project. The use for which the project is being built should be explained. Some parts of this description can be copied from the Program Report.

01 11 16 Work By Owner

1. The University may perform Work related to the project. This could involve a variety of departments and/or activities.

2. UT will assign a Project Manager to each project, whose responsibility it is to coordinate the design and team.
3. Work with the UT Project Manager to identify and list University-performed work. Examples, but not an all-inclusive list, of University-performed work may include cabling through the Information Technology Services (ITS) group, certification of fume hoods and hazardous material testing and abatement through the Environmental Health & Safety (EHS) group, etc. All parties must coordinate and cooperate on the work related to the project.

4. If the University furnishes items to be installed by any of the contractors, list the items and briefly indicate the work required of each contractor. Do not give detailed installation instructions; save details for the applicable section of the specifications.

01 12 00  MULTIPLE CONTRACT SUMMARY

01 12 19  Contract Interface

1. If other work, outside the scope of contracts for this project, will be performed simultaneously with the work on this project, explain how contractors must cooperate with outside contractors and with the University to avoid interferences with each other’s work.

01 20 00  PRICE AND PAYMENT PROCEDURES

01 21 00  ALLOWANCES

1. Generally not used, unless specifically approved by UT Project Manager prior to issuance of documents.

01 22 00  UNIT PRICES

1. Review Unit Price items with UT Project Manager prior to issuance of documents. Unit Prices will typically be obtained for those items where quantities cannot be reliably identified prior to beginning construction. Describe Unit Price items adequately, referring to other specification sections and the drawings where applicable.

01 23 00  ALTERNATES

1. A limited number of alternates may be used as a means of ensuring base bids within the available construction funds. The Design Professional shall consult with the UT Project Manager regarding alternates. Additive alternates are preferred over deductive alternates.

2. Care must be exercised to coordinate Plumbing, HVAC and Electrical alternates with General Contract alternates and with each other. When possible, alternates that are contingent upon one another should be identified as such and adjacent in the numbering sequence.

01 25 00  SUBSTITUTION PROCEDURES

01 25 13  Product Substitution Procedures

1. It is preferred that any and all Substitution Requests be submitted during the bidding process, a minimum of one week prior to the bid due date.

2. UT Austin may consider Substitution Requests during the submittal phase.
3. Substitution Requests must include reference to the specification for the product and drawings. Contractor must assure the following, without which the PSP and UT Austin will not consider the request:
   A. The proposed substitution will perform equal to or better than the specified product.
   B. The proposed substituted product(s) will interface with other project elements and/or components in the same manner as the specified product.
   C. The proposed substitution will carry the same or better performance and product warranty as the specified product.
   D. The proposed substitution will not negatively impact the project schedule. Anticipated schedule savings should be identified.
   E. The proposed substitution will not negatively impact the project budget. Anticipated budget savings should be identified.

4. UT Austin will not consider Substitution Requests for convenience, or for lack of planning.

5. The PSP should review all Substitution Requests with the UT Project Manager before providing an official response to the proposer(s).

01 29 00 PAYMENT PROCEDURES

01 29 73 Schedule Of Values

1. Contractor must submit to UT Project Manager within seven days of Notice to Proceed, and prior to Preconstruction Meeting.

2. Must be approved by UT Project Manager before submission of first pay application.

3. Format
   A. Follow MasterFormat 2004 for organization and content.
   B. Level of detail should be commensurate with complexity of project.
   C. Provide separate line items for labor and materials.
   D. PSP and UT Project Manager must work with contractor to include specific sustainability requirements in the Schedule of Values. This may include, but is not limited to identifying specific quantities and costs for particular project components that are required for submission to sustainability organizations.

01 30 00 ADMINISTRATIVE REQUIREMENTS

01 31 00 PROJECT MANAGEMENT AND COORDINATION

01 31 19 Project Meetings

1. Project meetings shall be held to coordinate various parties for the project. At the beginning of construction for a given project, the overall team, including Owner, Contractor(s) and PSP shall identify potential issues or areas requiring careful coordination. The team shall establish Project Meetings to address these issues, with appropriate timing and stakeholders.

2. Invite applicable campus departments to the Preconstruction Meeting, including but not necessarily limited to: UT EHS Department, UT Zone Shops, UT Instrumentation & Controls, UT Facilities Services, etc. Coordinate with the UT Project Manager.
01 32 00  CONSTRUCTION PROGRESS DOCUMENTATION

01 32 13  Scheduling Of Work

1. Contractor must submit Project Schedule, indicating major milestones, to UT Project Manager within seven days of Notice to Proceed, and prior to Preconstruction Meeting.

2. Level of detail should be commensurate with complexity of project.

01 32 19  Submittals Schedule

1. The Contractor must prepare a Submittals Schedule for review at the Preconstruction Meeting. The schedule should typically follow MasterFormat, and must show all anticipated submittals, and the approximate timing for their submission, to the PSP for review.

2. The Submittals Schedule should show interrelated submittals, or products that are part of a larger component. Submittals for such products/components must be submitted together. The PSP will not review partial submittals.

01 32 33  Photographic Documentation

1. The PSP is requested to document construction progress with digital photographs, as appropriate for the scale and complexity of work being performed. Include work that will be concealed, problem areas, etc. Photographs are to be submitted electronically to the UT PMCS Project Manager each month, on a compact disc. Identify the project name and University project number, date the photograph was taken, and exact location (such as, “Footing for Column B-9”).

2. The Contractor must also document construction progress with digital photographs, as appropriate for the scale and complexity of work being performed. Photographs are to be submitted monthly to the Design Professional on a compact disc as a Submittal, concurrent with the monthly Application for Payment. The Submittal documentation must identify the project name and University project number, date the photograph was taken, and exact location (such as, “Footing for Column B-9”).

3. All photographs must be of a resolution approved by UT Austin.

01 33 00  SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

1. When directed by the UT Project Manager, submittals will be handled electronically.

2. In some instances, paper copies may be submitted and/or requested.

01 35 00  SPECIAL PROCEDURES

01 35 13.19  Special Project Procedures for Healthcare Facilities

1. Include the UT EHS Department when initiating projects for Healthcare facilities, and throughout project development as required. Coordinate with the UT Project Manager.
01 35 13.43  Special Project Procedures for Contaminated Sites

1. Prior to conducting any work at known contaminated sites, review scope and procedures with the UT EHS Department. Coordinate with the UT Project Manager.

01 35 23  Owner Safety Requirements

1. Follow procedures outlined in the UT Construction Safety Program.


01 35 29  Health, Safety, and Emergency Response Procedures, including for contaminated sites.

1. Review requirements with the UT EHS Department and identify requirements in the contract documents. Coordinate with the UT Project Manager.

01 35 43  Environmental Procedures

1. Review information regarding hazardous materials and requirements for safe handling with the UT EHS Department for information.

2. Refer to the University of Texas’ Additional General Conditions for more information.

01 35 53  Security Procedures

1. Review any particular security concerns during the construction period with the UT Project Manager and include appropriate information and/or procedures in the contract documents.

01 35 91  Existing Building Treatment Procedures

1. Although none of the UT Austin campus’ buildings are listed on the Register of Historic Places, many structures on the campus, particularly those on the “original 40 acres,” have significant meaning to the University. Care should be used when working on or in campus buildings with such significance, in order to protect the integrity of the building(s) and campus fabric.

2. The Design Professional must:
   A. Recognize the historic fabric of the campus, and maintain the integrity and coherence of design as outlined in the UT Austin Campus Master Plan.
      1) Special attention must be paid to those spaces identified in the A Catalog of Historic and Significant Campus Interiors on the campus.
      2) If you are working on a space that is not specifically identified in the A Catalog of Historic and Significant Campus Interiors but appears to have unique historic integrity, review with your UT Project Manager.
   B. Coordinate review procedures for exterior and/or interior renovation work with the UT Project Manager.
   C. Coordinate with the UT Project Manager to conduct any necessary Stakeholder review meetings and obtain feedback.
01 40 00 QUALITY REQUIREMENTS

1. General
   A. Many times, existing conditions outside the scope of a particular project have an impact on the project. Some examples include accessibility to the site, code compliant toilet rooms, etc., for which the University has the responsibility to correct. UT Austin expects its design and construction partners to make the University aware of issues outside the project scope that may have an impact on the project and/or its budget.
   B. UT Austin expects its design and construction partners to identify and make the University aware of any interaction required with jurisdictions other than the University. This may include project reviews, required inspections, etc.

01 42 00 REFERENCES

01 42 19 Reference Standards

1. UT Austin follows a range of Life Safety and Building Codes, regulations and other standards to assure its buildings and campus meet a certain level of safety and construction quality.

01 50 00 TEMPORARY FACILITIES AND CONTROLS

1. Access to Facilities
   A. The University of Texas at Austin is a publicly owned institution, whose function and facilities are dedicated to serving specific operations and programs. In general, UT Austin allows Contractor personnel to use facilities such as existing toilet, food service or other facilities. In some cases, however, the Contractor personnel may be barred from using such facilities. Coordinate with UT Project Manager.

2. Utility Shut-Downs
   A. Contractors must coordinate all utility shut-downs with the UT Project Manager and building users. All shut-downs must be scheduled at least 72 hours (three business days) in advance of the shut-down, and the UT Project Manager will notify all building occupants.

01 51 00 TEMPORARY UTILITIES

1. Contractors must coordinate all temporary utilities required for prosecution of the work with the UT Project Manager. Specifications must be written to stress this point. The PSP must determine the type and scope of each utility needed during the construction documents phase and provide specific direction in the specifications regarding the arrangement for such utilities. Where deemed appropriate by the UT Project Manager, the Contractor must provide a Site Logistics Plan to inform all parties of intended site needs and usage.

2. Utility Company Installations
   A. Plans for running temporary lines through University property must be reviewed by the PSP in coordination with the UT Project Manager.

3. Connections to Existing Utilities
   A. If connections to University utilities are anticipated, the PSP needs to obtain drawings of existing utilities and consult with the UT Project Manager regarding services available and points of
connections to services. The specifications must provide instructions to the contractor(s) to make requests for these services through the UT Project Manager, who will provide contacts and/or any forms required.

4. Lay-Down Areas
   A. For small renovation projects, provisions must be approved by the UT Project Manager.

5. Parking
   A. Parking for Contractors on campus is limited. Provisions for parking will be coordinated with the UT Project Manager.

6. Cost
   A. The University will provide temporary utility services at no cost to the Contractor, unless directed otherwise by the UT Project Manager. Specifications must clearly identify each contractor’s responsibility for the installation of service lines, whether services are furnished by the utility company or by the University.

01 56 00 TEMPORARY BARRIERS AND ENCLOSURES

01 56 13 Temporary Dust Barriers
1. Review scope and methodology with the UT EHS Department. Coordinate with the UT Project Manager.
2. Prevent dust, fumes and odors from entering occupied areas.
3. Maintain dust partitions during the Work.
4. Perform daily and final construction cleanup using approved HEPA-filter equipped vacuum equipment.

01 56 19 Temporary Noise Barriers
1. Comply with requirements established by the UT EHS Department.

01 57 00 TEMPORARY CONTROLS

01 57 13 Temporary Erosion and Sediment Control
1. Comply with regulatory requirements and those established by the UT EHS Department. Coordinate with the UT Project Manager.

01 57 19 Temporary Environmental Controls
1. Provide protection, operate temporary facilities and conduct construction as required to comply with the environmental regulations and requirements established by the UT EHS Department. Coordinate with the UT Project Manager.

01 57 23 Temporary Storm Water Pollution Control
1. Comply with requirements of authorities having jurisdiction and requirements established by the UT EHS Department. Coordinate with the UT Project Manager.
01 60 00 PRODUCT REQUIREMENTS

01 61 00 COMMON PRODUCT REQUIREMENTS

01 61 13 Software Licensing Requirement

1. Where specific software is required on a project, such as with fire alarm systems, the PSP must coordinate with the UT Project Manager, and describe specific software requirements in the specifications.

01 66 00 PRODUCT STORAGE AND HANDLING REQUIREMENTS

1. Follow the UT EHS Department’s requirements for storage and handling of hazardous and/or toxic materials. Coordinate with the UT Project Manager.

01 70 00 EXECUTION AND CLOSEOUT REQUIREMENTS

01 74 00 CLEANING AND WASTE MANAGEMENT

01 74 19 Construction Waste Management and Disposal

1. In support of UT Austin’s commitment to sustainability, the PSP should identify a goal for construction partners to divert at least 50% of all non hazardous materials.

2. Follow requirements set forth by the UT EHS Department for disposal of hazardous waste.

01 77 00 CLOSEOUT PROCEDURES

01 77 19 Closeout Requirements

1. The PSP must outline the Contractor’s participation requirements for pursuit of environmentally sustainable project recognition, such as submission for a U.S. Green Building Council LEED certification. This information must be submitted to the PSP before final payment can be approved.

2. The PSP must outline the Contractor’s obligation for ongoing future participation in sustainable project certification after the project is closed out (such as the 5-year Post Occupancy Evaluation), and gain Contractor’s agreement in writing to take part as required.

01 78 00 OPERATIONS AND MAINTENANCE

1. The Contractor must provide a written certification that no asbestos-containing materials have been incorporated into the construction, whether the construction is new or a renovation. Reference the University of Texas construction contract, including Additional General Conditions, Supplemental Conditions and Special Conditions where applicable.

01 79 00 DEMONSTRATION AND TRAINING

1. The Contractor must coordinate with the UT Project Manager to demonstrate the operation of equipment and train University staff in ongoing maintenance. The number of training modules and quantity of training sessions, including providing video-recorded information, may vary from project to project.
01 80 00  PERFORMANCE REQUIREMENTS

01 81 00  FACILITY PERFORMANCE REQUIREMENTS

1. The University promotes energy efficient sustainable design, construction and building operations. Whenever possible, design practices, materials specified and construction activities must follow the UT Austin Sustainability Policy and the United States Green Building Council’s LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.

2. All new and major renovation projects, whether designed and constructed under the guidance of the UT System or the UT Austin Campus staff, must comply with the Energy Conservation Design Standard for New State Buildings, as issued by the State Energy Conservation Office (SECO). “Major Renovation” refers to projects of a certain level of complexity, a variety of different systems and components being installed, or other criteria as set by the University. The PSP must review with the UT Project Manager, and submit certifications and the project to SECO as required.

3. For new projects, consider building siting to take advantage of natural light, wind, shade, utility performance and other similar natural qualities.

4. Maximize energy efficiency for all new and major renovation projects.

5. Maximize Indoor Air Quality for all new and major renovation projects.

01 82 00  FACILITY SUBSTRUCTURE PERFORMANCE REQUIREMENTS

1. UT may desire to capture/recapture groundwater. Coordinate subsurface drainage requirements with the UT Project Manager.

01 83 00  FACILITY SHELL PERFORMANCE REQUIREMENTS

01 83 13  Superstructure Performance Requirements

1. Consider vibration requirements for building use and type.
   A. Critical criteria when designing structural system(s) to support equipment and/or machinery:
      1) The Design Resonant Speed (that speed which corresponds to the natural frequency of the spring-mass system consisting of the rotating components, bearing, lubrication, bearing housing and support pedestal of a fan system; the foundation is assumed to be infinitely rigid,) must be greater than, and preferably a minimum of 25% above, its Maximum Operating Speed, to avoid resonance.
      2) Fan RPM values must not exceed 1,000 RPM without UT Project Manager approval.
      3) Fan factory balancing must be accomplished such that direct drive fan bearing motions (inboard and outboard) do not exceed 0.80 mils peak-to-peak in any direction when measured in the “Filter In” mode at any operating speed; and 1.0 mils peak-to-peak for all other fans (belt-driven, FRP, etc.). On-site fan balancing will be required if the operational direct drive fan bearing motions (inboard and outboard) exceed 120 mils peak-to-peak in any direction, when measured in the “Filter Out” mode at any operating speed; and 1.5 mils peak-to-peak for all other fans. The vibration measurement system utilized must have a flat response down to 120 RPM.
      4) Velocity or acceleration vibration measurements are not acceptable.
5) Fan and air handler support structures must be capable of providing a direct transfer of unbalanced forces generated by the fan(s) and motor(s) to the supporting structural floor system. In that regard, floor member structural properties and connections must be given careful consideration.

B. Multi-story laboratory or laboratory-office buildings must meet vibration and structural dynamics criteria for Foot Traffic Impulse Excitation.

1) Provide calculations to validate proposed floor systems meet static stiffness values identified below. Cited values are floor Total Vibratory Motion, not just components of the motion. Total Vibratory Motion must be indicated by a plot of time versus structural motion.
   a. Office Areas: 1000 micro-inches, peak-to-peak, maximum total motion (vertical).
   b. General Laboratory Areas: 300 micro-inches, peak-to-peak, maximum total motion (vertical).
   c. Electron Microscopes and more sensitive equipment: 100 micro-inches, peak-to-peak, maximum total motion (vertical).

2) Above-cited criteria can typically be met by floor system designs that have the following center bay, minimum, static stiffnesses (vertical). Supply calculations to validate the cited stiffness is provided.
   a. 100,000 pounds/inch
   b. 400,000 pounds/inch
   c. 1,000,000 pounds/inch

2. Where appropriate, design for maximum flexibility as related to building size and function.

3. Use criteria set forth in The University of Texas at Austin’s Structural Criteria appendix for superstructure design.

01 83 16 Exterior Enclosure Performance Requirements

1. Design wall assembly to maximize thermal resistance. New exterior enclosure walls should be designed to a minimum R value of 25.

2. Prefer insulated metal panels over wood panels.

3. Exterior Insulation Finishing Systems (EIFS) are prohibited.

4. Glass
   A. Prefer minimal reflectance.
   B. Use low-e coating.
   C. Consider maintenance characteristics and acoustic performance when specifying glass.

5. Design floor assemblies over unconditioned space to provide a minimum R value of 25.

01 83 19 Roofing Performance Requirements

1. Consider context and relationship to other buildings in the vicinity.

2. Use clay tile roof where called for in the UT Austin Campus Master Plan.

3. Design roof assemblies to maximize thermal resistance. New roofs, whether flat or low-slope, or clay tile, should be designed to a minimum R value of 25.
4. Any renovation work impacting an existing roof must be constructed in such a way as to maintain the existing roof warranty, where applicable.

01 84 00 INTERIORS PERFORMANCE REQUIREMENTS

01 84 13 Interior Construction Performance Requirements

1. All new and major renovation projects must incorporate a Lactation/Quiet Room, meeting the requirements established by the UT Austin Human Resource Services department. Coordinate location with the UT Project Manager.

2. All new and major renovation projects must incorporate a Unisex Gender Neutral Toilet Room that also meets accessibility requirements set forth in the current adopted version of the Americans with Disabilities Act and Texas Accessibility Standards. Coordinate location with the UT Project Manager.

3. All new and major renovation projects must incorporate a Mail Room(s). Coordinate quantity, size and location with the UT Project Manager.

01 90 00 LIFE CYCLE ACTIVITIES

01 91 00 FACILITIES COMMISSIONING

01 91 13 General Commissioning Requirements (for projects managed by UT Austin Campus staff ("CP" projects)

1. General
   A. Commissioning is performed to ensure a facility functions as intended by the contract documents. Commissioning requires cooperation and direct involvement by all parties throughout the construction process. Participate in commissioning activities in coordination with UT staff and Commissioning Authority.
   B. Develop Project Description for each project to be commissioned.
      1) Commissioning Services will not apply to all projects, particularly those with limited scope (i.e., carpet replacement). However, where these services do apply, they are to be performed according to this guideline.
         a. The UT System has specific commissioning requirements for projects managed by the Office of Facilities Planning & Construction (OFPC) that may vary from this UT Austin campus standard. If a project is being managed by the UT OFPC, coordinate commissioning requirements with the UT OFPC Project Manager.
      2) Basic Commissioning is a Pre-Requisite for all projects pursuing LEED® Certification. Reference UT Austin’s Sustainability Policy for more information.
      3) When required, participate in development of Owner’s Project Requirements (OPR) with the overall project team, to identify and document the overall scope of the project. An OPR is typically developed for any campus-managed project that requires approval by the UT Board of Regents. When an OPR is not required for a project, assist the UT Project Manager in defining the project scope, to identify and document project requirements.
      4) Aid in development and maintenance of a Basis of Design (BoD) document as the project proceeds, providing input when requested by the Commissioning Authority. If a BoD is not required for a project, confirm the design meets the project scope document at each required submittal phase.
C. In conjunction with the UT Project Manager and UT Commissioning Authority, use the UT Commissioning Decision Matrix to determine Commissioning Risk and Commissioning Complexity Levels, and to establish the required Commissioning Level to implement for the project. This Decision Matrix assists in determining the type of Commissioning Services to be provided, and by whom.

1) Commissioning Level 1 is typically performed by a 3rd Party Commissioning Authority, for projects with high risk and high complexity.
2) Commissioning Level 2 is typically performed by the Contractor, with a 3rd Party Commissioning Authority’s oversight. This level typically occurs with projects of medium complexity and/or risk, and may include projects such as classrooms and/or office space.
3) Commissioning Level 3 is typically performed by the Contractor, for projects with low complexity and/or risk.
4) Commissioning Level 4 is typically performed by in-house staff from the UT Facilities Services Group, for minor renovation work.

2. Commissioning Activities - performed and/or coordinated by the Commissioning Authority

A. The Commissioning Authority can vary depending on the nature, scope and complexity of the project, whether the project is Campus-funded or System-funded, and the commissioning effort required. Commissioning may be:

1) UT Project Manager-led
2) UT Facilities Services-led
3) Contractor-led
4) 3rd Party-led, which is preferred to be independent of the Design firm.
5) Campus groups may have commissioning oversight. For instance, the Fire Safety Systems Shop (FSSS) provides oversight, with the UT Project Manager, for 3rd party testing.

B. Develop a Commissioning Plan and schedule, including a Responsibility Matrix.

C. The Commissioning Authority will coordinate completion of the following items:

1) Provide a complete list of contractor, major manufacturer, and major supplier contact information for inclusion in the Commissioning Manual.
2) Obtain a copy of the installation manual for all systems or equipment (typically by Contractor).
3) Establish the order, timing, and duration of the commissioning activities in conjunction with the construction schedule, for inclusion on the Master Project Schedule.
4) Develop and maintain an all-inclusive Commissioning Manual (or manuals) and keep it up-to-date. UT Facilities Services has examples for format, or also reference the US Green Building Council for examples and/or requirements.
5) Attend regularly scheduled Commissioning Team Meetings, as well as those in preparation for the testing. Maintain an Issues Log to confirm that identified deficiencies are being addressed and resolved. UT Facilities Services has examples for format, or also reference the US Green Building Council for examples and/or requirements.
6) Review shop drawings for systems and equipment being commissioned, to be sure equipment being provided matches those called for in the construction documents.
7) Develop testing plans to confirm equipment is operational and systems are working as designed and according to the appropriate sequence of operations.
8) According to agreed-upon/contracted scope of work, witness equipment and system testing, including pre-functional, functional and integrated systems testing. Document any items requiring follow-up in the Issues Log. Maintain attendance and sign-off logs and include in Commissioning Manual.
9) Document training requirements and confirm that Contractor coordinates Owner training.
10) Collate project record documents relating to Commissioning activities and turn over to owner at conclusion of project.
a. Commissioning Manual(s), also known as “C&C Manual(s)”, including all information gathered as part of the Commissioning process. This manual is maintained by the Contractor and reviewed by the Commissioning Authority.

b. Review Owner’s Operation & Maintenance Manual(s) and all contract documents.

11) Participate in a “Lessons Learned” discussion with the Owner to highlight processes that went smoothly and recommend adjustments that might improve the process.

D. Confirm that Contractor has submitted complete and accurate Equipment Add/Delete forms to the UT Project Manager, using either University-standard forms that are available from the UT Project Manager, or project-specific forms.

E. For new construction and major renovation projects, or as identified by the UT Project Manager, projects are to be re-commissioned after the building is fully occupied, preferably in the 10th or 11th month after Substantial Completion and near the end of the Warranty Period. This will identify any repairs requiring attention prior to expiration of the warranty period. The party(ies) performing this re-commissioning process will depend upon contracted scope for 3rd party commissioning services; this effort may be carried out by the UT Facilities Services group.

01 94 00 FACILITY DECOMMISSIONING

1. Coordinate Decommissioning requirements with the UT EHS Department and the UT Project Manager.
02 00 00  GENERAL PROVISIONS

1. Sustainable Design:
   A. The University promotes energy efficient green design, construction and building operations.
   B. Whenever possible, materials are to be selected and specified following UT Austin’s Sustainability Policy and the United States Green Building Council’s LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.

2. It is recognized that project conditions and requirements vary, and all items identified herein may not apply in all cases.

02 01 00  MAINTENANCE OF EXISTING CONDITIONS

1. Through UT Project Manager, coordinate maintenance of site remediation, underground storage tank removal, facility remediation and/or hazardous waste drum handling with the UT EHS Department as required.

02 06 00  SCHEDULES FOR EXISTING CONDITIONS

1. Coordinate schedules for subsurface investigations, site remediation, underground storage tank removal, facility remediation and/or hazardous waste drum handling with the UT EHS Department, through the UT Project Manager.

02 20 00  ASSESSMENT

02 21 00  SURVEYS

1. PSP must provide the UT Project Manager with a drawing identifying the area to be surveyed, as well as type of survey and all information required. The survey will be initiated by the UT Project Manager.

2. Confirm reference points (i.e., local benchmarks, State coordinates grid system, U.S. Geological Survey, etc.) with UT Project Manager.

02 24 00  ENVIRONMENTAL ASSESSMENT

1. Coordinate Environmental Assessment requirements with the UT EHS Department, through the UT Project Manager.

02 26 00  HAZARDOUS MATERIAL ASSESSMENT

1. Coordinate Hazardous Material Assessment requirements with the UT EHS Department, through the UT Project Manager.

02 30 00  SUBSURFACE INVESTIGATION

02 32 00  GEOTECHNICAL INVESTIGATIONS

1. General
   A. Review any available existing information at or near the proposed construction site.
B. Obtain preliminary design information specific to the project including, but not limited to, layout, column or continuous loadings, loading types and conditions, etc.
C. PSP must identify locations and depths for geotechnical testing, and provide this information to the UT Project Manager, who will coordinate the work.
D. Coordinate with the UT Utilities group to determine any current or future underground obstructions.
E. Coordinate work with campus entities that might be affected by the work, including Environmental Health and Safety (EH&S), Parking & Traffic, the UT Police Department, and others.
F. All spoils or liquid waste must be captured and contained at the project site. No runoff is permitted.

2. Geotechnical Report
A. Must be prepared and sealed by a registered geotechnical engineer with five (5) years of continuous related work in the Austin, Texas area.
B. All geotechnical work and recommendations must be supervised by a professional engineer registered in the State of Texas.
C. Number, depth and locations of borings are based on the proposed structure and the geotechnical engineer’s requirements.
D. Minimum Report requirements:
   1) Background Information.
   2) Boring location plan.
   3) Generalized subsurface profiles, indicating stratigraphic and structural relationships.
   4) General foundation construction requirements, including loading capabilities and construction limitations. Also include pavement section recommendations for various traffic types.
   5) Groundwater conditions and anticipated effects on construction.
   6) 25, 100 and 500 year floodplains.
   7) Recommendations for earthwork, subgrade preparation, and fill placement and compaction.
   8) Acceptability of on-site materials for construction.
   9) Excavation procedures.
   10) Any other items that could affect construction or the long-term performance of the foundation.

E. As applicable to the specific project, the Report must provide information regarding lateral earth pressures, temporary construction procedures, dewatering procedures, subgrade drainage, trench safety, subgrade stabilization and piling, drilled shafts and sheet piling.

3. Miscellaneous requirements for inclusion in foundation design recommendations:
A. Use polyethylene sheeting below all slabs on grade.
B. Use a foundation isolation system for structures that are subject to high plasticity soils.
C. Subgrade drainage system:
   1) Required at perimeter of all foundation elements that are occupied on one side and have exposed earth on the other side.
   2) Geotechnical engineer must recommend system design and elements.
   3) System may be required to drain into water-recovery system.

02 40 00  DEMOLITION AND STRUCTURE MOVING

02 41 00  DEMOLITION

1. Coordinate requirements with the UT EHS Department and the UT Austin Sustainability Policy.
2. Reference Section 01 94 00 Facility Decommissioning.
02 42 00 REMOVAL AND SALVAGE OF CONSTRUCTION MATERIALS

1. Coordinate requirements with the UT Austin Sustainability Policy.

2. Examples of historic items are documented in A Catalog of Historic and Significant Campus Interiors, created and maintained by the UT Austin Project Management and Construction Services department. Coordinate with the UT Project Manager to maintain items that appear to represent historic value. The following list describes some, but not necessarily all such items:
   a. Building cornerstone(s)
   b. Time capsules
   c. Built-in features, such as niches, lockers, etc.
   d. Clocks
   e. Decorative painting
   f. Doors
   g. Interior exposed brick
   h. Fireplaces and mantels
   i. Specialty flooring
   j. Furniture
   k. Grilles
   l. Hardware
   m. Light fixtures
   n. Molding or trim
   o. Paneling and/or shelving
   p. Railings
   q. Signage and lettering
   r. Special finishes, such as murals, plaster, gold leaf, etc.
   s. Stained or leaded glass
   t. Special ceilings, such as vaulted, exposed beams, etc.

3. Any carpet removed for renovation must be recycled. Coordinate with the UT Project Manager.

02 50 00 SITE REMEDIATION

1. Coordinate requirements with the UT EHS Department, through the UT Project Manager.

02 60 00 CONTAMINATED SITE MATERIAL REMOVAL

1. Coordinate requirements with the UT EHS Department, through the UT Project Manager.

02 80 00 FACILITY REMEDIATION

A. Coordinate all activities related to facility remediation with the UT EHS Department, through the UT Project Manager.
PART 1: GENERAL

1.01 Scope of Standard

A. The scope of this standard includes recommendations for the specification of cast-in-place concrete.

1.02 Related Standards

A. Structural Systems (currently The University of Texas Office of Facilities Planning and Construction Owner’s Design Guidelines, Section K, Structural Criteria).

1.03 Reference Standards

A. The current editions of the applicable American Concrete Institute (ACI) publications, to the extent applicable in each reference.

B. The current editions of the applicable American Society for Testing and Materials (ASTM) specifications, to the extent applicable in each reference.


1.04 Environmental Controls

A. Rinsing out of the transit mix trucks, washing or wetting of concrete, site cleanup, or other activity related to water at the site shall be in strict conformance with all EPA requirements for the prevention of water runoff to stormwater sewers or creeks.

PART 2: PRODUCTS

2.01 Materials

A. All concrete shall be normal weight concrete weighing not more than 145 pcf, unless otherwise required.

B. Cement

1. Cement shall conform to one of the following:

<table>
<thead>
<tr>
<th>Type/ASTM No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA/C150</td>
<td>Standard portland cement.</td>
</tr>
<tr>
<td>IIA/C150</td>
<td>Provides moderate sulfate resistance or moderate heat of hydration.</td>
</tr>
</tbody>
</table>
SECTION 03300 – CAST-IN-PLACE CONCRETE
CONSTRUCTION STANDARD

IIIA/C150 Produces high early strength.
IPA/C595 Type I cement blended with a pozzolan (20% by weight maximum of the cement/pozzolan blend).
E-IKA/C845 Contains anhydrous calcium aluminosulfate, calcium sulfate, and uncombined calcium oxide.

2. Only one type and brand of each type of cement will be permitted in any one structure.

C. Flyash

1. Conform to ASTM C618, Class F. Class F flyash is generally the best class of flyash to use. However, flyash varies from area to area and from year to year so the source and quality should always be checked carefully.

2. Flyash shall be produced from a single known and consistent source.

3. The amount of flyash used shall be no greater than 20 percent by volume of the specified cement volume (cement is specified by weight, which can be converted to an equivalent volume).

4. Flyash shall not be used in architecturally exposed concrete.

D. Aggregates

1. Aggregates shall conform to ASTM C33.

2. Use coarse aggregate from only one source and fine aggregate from only one source for exposed concrete in a single structure.

E. Mixing Water shall be potable.

F. Admixtures

1. The use of a superplasticizer is recommended, especially where waterproofing is required since it helps to produce a denser, more water-resistant concrete.

G. Chlorides are not permitted in any form.

H. Reinforcing Steel

1. Conform to ASTM A615, Grade 60 (#3 bars shall be Grade 40).
2. Welded wire fabric shall be supplied in flat sheets only.

I. Waterstops

1. A major problem with flexible waterstops is that they are often displaced during concrete placement. Thus watertightness is impaired. The drawings and/or specifications should carefully address proper placement of flexible waterstops. Some waterstops are manufactured with wire embedded in them that allow the waterstops to be tied off more securely during concrete placement. Since waterstops are critical to watertightness in a structure, these reinforced waterstops should be considered.

2. Splices should be fused or "welded" in accordance with the material chosen and the manufacturer's recommendations.

3. Where “adhesive” or “rope” waterstops are specified, the products shall have a proven life consistent with expected life of the structure being designed.

2.02 Proportioning of Concrete

A. Select proportions of ingredients to produce a concrete having proper workability, durability, strength, and appearance. Proportion ingredients to produce a mixture that will work readily into corners and angles of forms and around reinforcement by methods of placing and consolidation employed on the project.

B. The maximum recommended allowable water/cement or water/cement-pozzolan ratio shall not exceed 0.47. Include free water in the aggregate in all water/cement or water/cement-pozzolan ratio computations.

C. Air entrainment shall be included in all concrete mixes, unless required otherwise.
PART 3: EXECUTION

3.01 Rinsing Trucks

A. Rinsing of transit mix trucks or other concrete mixing devices shall either be off of the Owner’s site or onsite in a contained area, which does not allow run-off. If rinsed in a contained area onsite, run-off must be prevented until concrete dries, at which time it must be removed as solid debris.

3.02 Reinforcing

A. Reinforcing bars field cut on the job shall be cut by shearing or sawing. Field cutting with a torch is not acceptable.

B. Welding of reinforcing bars is prohibited. Mechanical methods for splicing bars are preferred.

3.03 Construction Joints

A. Construction joints should be shown on the drawings to assure that the Contractor does not place joints where watertightness or strength of the structure will be impaired. A note should be placed on the drawings that all construction joints not shown on the drawings should be submitted to the Engineer for approval.

B. Constructability is very important to assure good concrete placement. Therefore, the Engineer should be careful in reviewing proposed joints so that those necessary for constructability are not rejected.

C. 100% of reinforcing shall be continuous across construction joints.

3.04 Control Joints

A. Control joints are herein described as joints that are designed to allow for movement either from contraction or expansion.

B. Contraction joints allow for contraction of the concrete and also function as construction joints.

1. Fifty percent of reinforcing shall be continuous across contraction joints.

2. If saw-cutting of contraction joints is allowed, the following shall be adhered to:
a. During hot and dry periods, saw-cutting should occur within 4 to 12 hours of concrete placement.

b. During cool and moist periods, saw-cutting should occur within 24 hours of concrete placement.

3. Where applicable, use waterstops to assure watertightness.

C. Expansion joints allow for expansion of the concrete and also function as construction and contraction joints.

1. Reinforcing shall not be continuous across expansion joints, except for shear transfer as noted below.

2. For shear transfer, use smooth dowels with expansion caps on one side.

3. Expansion joints should be considered at approximately 120 foot spacing as a general rule.

4. Where applicable, use waterstops to assure watertightness.

3.05 Concrete Finishing

A. Carefully specify the types of concrete finishing required for all areas of the structure to assure proper finishing and to avoid costly change orders due to lack of definition on the drawings or in the specifications.

1. Rough form finish shall be in accordance with ACI 301, Section 10.2.1. This is the roughest finish and is recommended for surfaces that will not be visible in the completed structure.

2. Smooth form finish shall be in accordance with ACI 301, Section 10.2.2. A smooth form finish is recommended for surfaces to be coated or where appearance is not important.

3. Smooth rubbed finish shall be in accordance with ACI 301, Section 10.3.1. A smooth rubbed finish requires an initial smooth form finish as required above. A smooth rubbed finish is recommended for surfaces that will not be coated and do not require a highly finished appearance. A smooth rubbed finish should also be used if recommended by the manufacturer of the specified protective coating(s).

4. Grout cleaned finish shall be in accordance with ACI 301, Section 10.3.2. A grout cleaned finish requires an initial smooth form finish as
required above. A grout cleaned finish is recommended for surfaces that will not be coated but do require a highly finished appearance. A grout cleaned finish is labor intensive and requires some skill to produce the desired results. Therefore, the Contractor's procedure must be monitored carefully to assure that a proper finish is obtained. Depending on the project, a protective coating can be more cost effective.

5. Tops of walls and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed. Float unformed surfaces to a texture consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly across the unformed surfaces.

B. Carefully specify the finishing slabs and similar flat surfaces for all areas of the structure to assure proper finishing and to avoid costly change orders due to lack of definition on the drawings or in the specifications.

1. Floated finish. Usually most slabs and flat surfaces receive a floated finish, except as noted below.

2. Troweled finish. Usually a troweled finish is specified where a nicer finished appearance is desired or where floor coverings will be applied.

3. To obtain a broom, belt, or rake finish, immediately upon completing a floated finish, draw a broom or rake across the surface to give a coarse transverse scored texture. Usually a broom, belt, or rake finish is specified for sidewalks and ramps.

3.06 Testing and Control

A. The Contractor shall be required to employ, at his expense, a commercial testing laboratory, acceptable to the Owner, to prepare and test the initial mix design for each class of concrete specified.

B. In addition to the initial mix design(s), the Contractor shall be required to employ, at his expense, a commercial testing laboratory, acceptable to the Owner, to prepare and test the mix design for each class of concrete for which the material source has been changed.

C. Field Test Cylinders During Construction.
1. Mold four cylinders for each set of tests specified.
2. Test one specimen at 7 days and two at 28 days according to ASTM C39. If one, or both, of the 28-day tests indicate a compressive strength below the strength required, the fourth specimen shall be tested at 56 days. If all tests indicate a compressive strength below the strength required, the Engineer may, at his discretion, direct the Contractor to perform testing of in-place concrete at no additional cost to the Owner, regardless of the outcome of the tests.

3. The Contractor may, at no additional cost to the Owner mold additional cylinders for earlier strength testing or other reason as may be required by the Contractor.

3.07 Testing of Deficient In-place Concrete

A. The strength of the concrete will be considered potentially deficient if the averages of two consecutive sets of strength test results fail to equal or exceed the specified strength or if any individual strength test result falls below the specified strength. Testing may be required as directed by the Engineer.

B. Concrete work not having the required strength, as determined by the Engineer, shall be replaced at the Contractor's expense.

C. The Contractor shall bear all costs incurred in providing the additional testing and/or analyses required as a result of deficient in-place concrete. All costs as a result of delays due to additional testing and/or analyses will be at the Contractor's expense, with no extension of contract length, regardless of the outcome of the testing.

3.08 Acceptance of Concrete Work

A. Formed surfaces resulting in a configuration of members smaller than permitted under the tolerances specified shall be considered deficient and repaired or replaced as directed by the Engineer.

B. Concrete members cast in the wrong location shall be rejected if the strength, appearance, or function of the structure is, in the Engineer's opinion, adversely affected or if misplaced members interfere with other construction. If rejected, remove members cast in the wrong location and repair or replace at the Contractor's expense as directed by the Engineer.

C. All work required under this section shall be at the Contractor's expense, with no extension of contract length.

END OF STANDARD 03300
SECTION 03400 – STRUCTURAL PRECAST CONCRETE
CONSTRUCTION STANDARD

PART 1: GENERAL

1.01 SCOPE OF STANDARD

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for the design, fabrication and erection of structural precast concrete systems.

1.02 RELATED STANDARDS

A. Structural Systems.
B. Cast-In-Place Concrete
C. Joint sealants.

1.03 REFERENCE STANDARDS

A. PCI Design Handbook.
B. PCI MNL-116 Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
D. ACI 301 Specifications for Structural Concrete for Buildings.

1.04 QUALITY CONTROL

A. The precast concrete fabricator shall provide evidence of successful fabrication of precast concrete structures of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date. The precast fabrication plant must be PCI certified under the PCI Plant Certification Program. Fabricator must also provide evidence that the plant has sufficient production capacity to produce the required units within the allotted time on the project schedule.

B. The precast concrete erector shall provide evidence of successful erection of precast concrete structures of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.

C. Qualifications for welding work: All welders and welding processes shall be qualified in accordance with AWS “Standard Qualification Procedure.” All welders shall have passed AWS qualification tests within the past six months.

D. The building erector is required to visit the project site at least 30 days prior to start of erection to review existing site conditions such as site access, clearances, utilities, adjacent structures, overhead obstructions, site topography and security requirements.
1.05 SUBMITTALS

A. Fabricator shall submit, as a minimum, the following:

1. Mill certificates for all reinforcing steel, steel embeds, and prestressing tendons.

2. Mix designs for all classes of concrete to be used in the project.

3. Complete shop drawings, including placement plans, member sizes, inserts, reinforcing, embeds, connection details, bill of materials, dimensions of members, joints, and locations of splices.

4. Submit complete structural design calculations sealed by a Registered Professional Engineer licensed in the State of Texas. Calculations shall be submitted for all members and connections, and shall include both vertical and lateral load analyses.

5. Fire-Resistance Rated Precast Units – Where precast concrete units are shown or scheduled to meet certain fire resistance classifications, provide units tested and listed by Underwriters Laboratories (U.L.) in the U.L. Fire Resistance Directory, or with each unit bearing the U.L. label and marking.

PART 2: PRODUCTS

2.01 GENERAL

A. All precast concrete and materials to produce the precast units shall be domestically manufactured, unless foreign sources are accepted by the University of Texas.

PART 3: EXECUTION

3.01 ERECTION

A. Prior to erection, erector shall check elevations of concrete and masonry bearing surfaces, locations of anchor bolts and similar devices before proceeding with erection. Report any discrepancies to U.T. project representative.

B. Erector is responsible for all temporary shoring and bracing.

C. Level and plumb individual members and precast frame to within ACI tolerances.

3.02 QUALITY CONTROL

A. The University of Texas will contract with an independent testing agency to provide inspection services during the course of the project. The fabricator and the erector shall provide access to all parts of the work for inspection by the testing agency to accomplish its work. The testing agency may require access to the fabricator’s shop at any time during fabrication or just prior to shipment of the precast concrete units.

B. The University of Texas reserves the right to reject any and all materials or workmanship not complying with specified requirements at any time.
C. Fabricator and/or erector shall correct all deficiencies and work which is not in compliance with the specified requirements. Any additional testing or inspection costs will be at the expense of the fabricator/erector.

PART 4: DESIGN

4.01 GENERAL

A. In the design of structural steel systems, the design engineer shall take into consideration the future flexibility of the system and the need to make frequent modifications to building systems.

B. The detailing of connections and joints in precast concrete is particularly important in order to prevent cracking and reduce long-term maintenance problems in the structural system. Expansion and contraction of the structure due to thermal movements must be considered and dealt with appropriately in the design.

C. The design engineer should also give careful consideration to exposure conditions and possible corrosion of the reinforcing in precast members. The cover requirements must be adjusted to ensure long-term serviceability of the system.

D. If the Contractor is permitted to submit this as an alternate, there must be an agreement of design standards by UT-Austin _____?_____. the alternate system is equivalent.

4.02 DESIGN

A. Refer to U.T. Structural Systems standard for design loads.

B. Live load reduction shall be in accordance with the U.T. Structural Systems standard.

C. Deflections - Unless approved by the U.T. Structural Engineer, steel member deflections shall be limited to the following:

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<th>Deflection Limit</th>
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<tr>
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<td>L / 360</td>
</tr>
<tr>
<td>Dead Load + Live Load</td>
<td>L / 240</td>
</tr>
</tbody>
</table>

In addition, the engineer should give due consideration to the control of excessive floor vibration and to the control of pounding on roofs. The engineer shall also consider the affect of deflections on architectural finishes attached to the structural members. In some cases, it may be necessary to provide greater stiffness than the above deflection limits require.

D. Lateral Forces – In the design of precast concrete systems for lateral loads, the use of a braced frame (usually this accomplished with precast concrete shear walls) is preferred in order to reduce the chance of cracking in brittle finishes. The use of a Moment-Resisting Frame to resist lateral forces is at the discretion of the U.T. Structural Engineer.

E. Prestressing Tendons – All prestressing tendons shall be 7-wire, low-relaxation strand meeting the requirements of ASTM A416. All tendons shall be bonded unless approved the University of Texas Structural Engineer.

F. Control Joints in Toppings – The topping slabs in precast concrete systems tend to crack over essentially every joint between precast members. For instance, in parking
garages the topping slab usually cracks at the ends of double tees and at the joints between adjacent double tees. In order to control these cracks, continuous control joints (minimum width = \_\_\_\_\_\_\) shall be installed in the topping slabs over all joints between the precast members below. This includes the joints between double tees and their supporting beams or walls and at the joint between adjacent double tees. The control joints may be hand scored with a long straight-edge (minimum length = 10 feet) before the concrete sets, or the joints may be sawcut with a soft-cut saw within 8 - 12 hours of concrete placement. After the concrete has cured, the joints shall be ground, primed, and sealed with a high quality, two component, traffic-grade polyurethane or polysulfide sealant.

G. Expansion Joints – Expansion joints in the precast structural system must be sized appropriately and designed for the proper loading conditions. Expansion joint systems which are embedded or recessed into the concrete topping are preferred.

4.03 SYSTEMS TO AVOID

A. Avoid precast members with excessive span/depth ratios. Deflections should be kept within acceptable limits.

B. Avoid the use of unbonded tendons.

C. Avoid steel yield strengths higher than 36 ksi, except for tubular steel members which can be 55 ksi.

END OF STANDARD 03400
SECTION 04200 – MASONRY UNITS
CONSTRUCTION STANDARD

PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for manufactured units of masonry, both load bearing and non-load bearing.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Refer also to Section 07940 for general guidance concerning the specific preferences of UT-Austin for jointing of exterior vertical surfaces for concrete and masonry.

B. Reinforced Grouted Brick Masonry, Masonry Institute of America

C. Masonry Veneer (Second Edition), Masonry Institute of America

D. Reinforced Masonry Engineering Handbook (Fifth Edition Updated), Masonry Institute of America.

E. 1997 Masonry Codes and Specifications, Masonry Institute of America

F. Reinforcing Steel in Masonry, Masonry Institute of America

G. Technical Notes on Brick Construction, Brick Industry Association


1.03 Quality Control

A. Campus brick: UT-Austin campus has a standard range of colors for selection of the campus brick. The palette of brick colors listed in Products shall be used to create the brick blend for each new building. All brick must meet master plan requirements.

B. Grout: Coordinate color of mortar with the UT project representative. Use only a pre-mixed mortar, with no calcium chloride admixtures.

Repointing should occur in advance of cleaning, unless authorized by UT project representative.
C. Masonry Mock Up: Consultant shall design and specify a masonry mock up having sufficient detail to allow for necessary UT Austin approvals. Mock up will be constructed no later than three months prior to needing masonry delivered to the construction site. Locate in full sun and as directed by UT Austin representative.

PART 2: PRODUCTS

2.01 Brick

A. Acme Brick Co., or equal as approved by Design Manager.

B. Acceptable brick units (to be blended per agreement of consultant and UT Austin):

   Acme KAP blend T402 (orange) modular velour
   Acme DTP blend 100 flashed (darker gold/brown) modular velour
   Acme DTP blend 105 flashed (light gold/light brown) modular velour
   Acme DTP blend TCJC (gold/pink/buff) modular heritage

C. Consultant shall arrange to bring brick supplier into the design process early to verify any new developments in brick production that may impact brick unit appearance or delivery.

PART 3: EXECUTION

3.01 General

A. Refer to Section 05800 for expansion and control joint detailing.

END OF STANDARD 04200
PART 1: GENERAL

1.01 Scope of Standard
   A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for natural and cut stone.
   B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards
   A. Refer to the UT Campus Master Plan for guidelines pertaining to use of stone. Successful maintenance guidelines shall be developed and approved prior to the specification or installation of any porous stone. Use caution when specifying use of shellstone limestone at locations where it is exposed to rainfall.
   B. Coordinate with UT Statuary conservator where applicable.
   C. Marble and Stone Slab Veneer, (Second Edition), Masonry Institute of America.
   D. Dimension Stone Design Manual, Marble Institute of America.

1.03 Quality Control
   A. Details for installation, and cleaning shall be approved by the UT project representative prior to specification or installation of any porous stone.

PART 2: PRODUCTS

2.01 Stone
   A. Limestone: Cordova cream limestone saw cut, Texas Quarries or equal as approved by UT project representative.
   B. Granite: Sierra white, Cold Spring Granite Co., or equal as approved by UT project representative.
   C. Anchors: Use only stainless steel.
SECTION 04400– STONE
CONSTRUCTION STANDARD

PART 3: EXECUTION

3.01 General

A. Provide drips where stone projects more than one inch.

B. Avoid using cordova cream limestone where it extends below finished grade at lawn or planting beds.

C. Provide masonry mock up for approval at least three months prior to needing stone on site.

END OF STANDARD 04400
PART 1: GENERAL

1.01 Scope of Standard
A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for cast stone, simulated stone, and other types of simulated masonry.
B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards
A. Cast stone: Refer to the UT Campus Master Plan for guidelines pertaining to use of cast stone. Successful maintenance guidelines must be developed and approved by UT architectural representative prior to the specification or installation of cast stone.
B. Technical manual with case histories:
   Cast Stone Institute of America
C. “Cast Stone Institute Technical Bulletins 32-45”:
   Cast Stone Institute
D. Dimension Stone Design Manual
   Marble Institute of America

1.03 Quality Control
A. Cast stone resurfacing: As the UT-Austin campus is a historic district, in no instance will it be acceptable to paint finish cast stone surfaces.
B. Details for installation, and cleaning must be developed and coordinated through the UT project Design Manager.

PART 2: PRODUCTS NOT USED

Design & Construction Standards, Revised December 14, 2001  04700-1
SECTION 04700 – SIMULATED MASONRY
CONSTRUCTION STANDARD

PART 3: EXECUTION NOT USED

END OF STANDARD 04700
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for materials, equipment, and services for the cleaning and restoration of masonry.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Expansion joints in masonry: Section 07940, JOINTING OF EXTERIOR VERTICAL SURFACES.

B. Finishes: Section 09950, COATINGS AND PAINT SYSTEMS.

C. The Secretary of the U.S. Department of the Interior’s Standards for Rehabilitation.


E. Clear Water Repellent Treatments for Concrete Masonry, Masonry Institute of America.


1.03 Quality Control

A. Masonry resurfacing: As the UT-Austin campus is a historic district, in no instance shall it be acceptable to paint masonry surfaces.

1.04 General Requirements

A. Masonry cleaning: Cleaning shall be limited to the gentlest means possible. Test areas in inconspicuous locations. Tests must be approved by University project representative. Low pressure wash no greater than 400 psi unless authorized by University project representative. In no instance shall sandblasting be acceptable. Compliance with the Office of Environmental Health and Safety is required. See 3.01A below.
B. Masonry restoration: Historic buildings’ grout re-pointing shall comply with the UT-Austin campus historic restoration recommendations. Extreme care shall be taken during the repointing process. Use of hand tools is required.

PART 2: PRODUCTS

2.01 Sealants

A. General

1. Sealant: If use of a water repellent sealer is proposed, the sealant shall be a “breathable” type, and shall be approved by UT project representative and the Texas Historical Commission. Use Water based materials when possible.

PART 3: EXECUTION

3.01 Discharges

A. Discharges from pressure washing shall not be allowed to enter a storm sewer or waterway. Vacuum the water for disposal off-site or berm the process water and allow it to evaporate. If the rinsate only contains water and dirt or sediment, it may be spread on the ground only with written prior permission from the University of Texas at Austin Office of Environmental Health and Safety.

END OF STANDARD 04930
PART 1: GENERAL

1.01 SCOPE OF STANDARD

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for the design, fabrication and erection of structural steel building systems.

1.02 RELATED STANDARDS

A. Structural Systems.

B. Steel Joists and Joist Girders

C. Coatings and Paint Systems

1.03 REFERENCE STANDARDS

A. AISC Specification for Structural Steel Buildings.


C. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

D. AISC Manual of Steel Construction.


1.04 QUALITY CONTROL

A. The structural steel fabricator shall provide evidence of successful fabrication of structural steel buildings of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.

B. The structural steel erector shall provide evidence of successful erection of structural steel buildings of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.

C. Qualifications for welding work: All welders and welding processes shall be qualified in accordance with AWS “Standard Qualification Procedure.” All welders shall have passed AWS qualification tests within the past six months.

D. The building erector is required to visit the project site at least 30 days prior to start of erection to review existing site conditions such as site access, clearances, utilities, adjacent structures, overhead obstructions, site topography and security requirements.
1.05 SUBMITTALS

A. Fabricator shall submit, as a minimum, the following:

1. Mill certificates for all steel members.

2. Complete shop drawings, including placement plans, member sizes, connections, connection details, bill of materials, and dimensions of members and locations of splices.

3. All primers, coatings and cleaning methods.

PART 2: PRODUCTS

2.01 GENERAL

A. All steel shall be domestically manufactured, unless foreign sources are accepted by the University of Texas.

B. Primer paint shall be compatible with subsequent paint systems to be applied.

PART 3: EXECUTION

3.01 ERECTION

A. Prior to erection, erector shall check elevations of concrete and masonry bearing surfaces, locations of anchor bolts and similar devices before proceeding with erection. Report any discrepancies to U.T. project representative.

B. Erector is responsible for all temporary shoring and bracing.

C. Level and plumb individual members and steel frame to within AISC tolerances.

3.02 QUALITY CONTROL

A. The University of Texas will contract with an independent testing agency to provide inspection services during the course of the project. The fabricator and the erector shall provide access to all parts of the work for inspection by the testing agency to accomplish its work. The testing agency may require access to the fabricator’s shop at any time during fabrication or just prior to shipment of the structural steel.
B. The University of Texas reserves the right to reject any and all materials or workmanship not complying with specified requirements at any time.

C. Fabricator and/or erector shall correct all deficiencies and work, which is not in compliance with the specified requirements. Any additional testing or inspection costs will be at the expense of the fabricator/erector.

PART 4: DESIGN

4.01 GENERAL

A. In the design of structural steel systems, the design engineer shall take into consideration the future flexibility of the system and the need to make frequent modifications to building systems.

4.02 DESIGN

A. Refer to U.T. Structural Systems standard for design loads.

B. Live load reduction shall be in accordance with the U.T. Structural Systems standard.

C. Deflections - Unless approved by the U.T. Structural Engineer, steel member deflections shall be limited to the following:

- Live Load Only: \( \text{L} / \text{360} \)
- Dead Load + Live Load: \( \text{L} / \text{240} \)

In addition, the engineer should give due consideration to the control of excessive floor vibration and to the control of pounding on roofs. The engineer shall also consider the affect of deflections on architectural finishes attached to the structural members. In some cases, it may be necessary to provide greater stiffness than the above deflection limits require.

D. Lateral Forces – In the design of structural steel systems for lateral loads, the use of a braced frame is preferred in order to reduce the chance of cracking in brittle finishes. The use of a Moment-Resisting Frame to resist lateral forces is at the discretion of the U.T. Structural Engineer.

E. Full-Penetration Welding – Full-penetration welds are often required and even desirable for many structural steel connections. However, the use of full-penetration welding should be limited due to both cost and testing requirements. The engineer should give consideration to these factors when designing structural steel connections.
4.03 SYSTEMS TO AVOID

A. Avoid steel systems with excessive span/depth ratios. Deflections should be kept within acceptable limits.

B. Avoid the use of “weathering steel” rolled sections or sheet metal panels.

C. Avoid the use of A-490 bolts.

END OF STANDARD 05100
PART 1: GENERAL

1.01 SCOPE OF STANDARD

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for the design, fabrication and erection of steel joist and/or joist girder structural systems.

1.02 RELATED STANDARDS

A. Structural Systems.
B. Structural Steel
C. Coatings and Paint Systems

1.03 REFERENCE STANDARDS

A. AISC Specification for Structural Steel Buildings.
C. Steel Joist Institute Specifications.
D. AISC Manual of Steel Construction.

1.04 QUALITY CONTROL

A. The steel joist fabricator shall provide evidence of successful fabrication of steel joist systems of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date. The joist fabricator shall also employ and have on staff a qualified structural engineer licensed in the State of Texas to prepare design calculations, shop drawings, and other structural data for steel joists and joist girders.

B. The steel joist erector shall provide evidence of successful erection of steel joist systems of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.

C. Qualifications for welding work: All welders and welding processes shall be qualified in accordance with AWS “Standard Qualification Procedure.” All welders shall have passed AWS qualification tests within the past six months.

D. The joist erector is required to visit the project site at least 30 days prior to start of erection to review existing site conditions such as site access, clearances, utilities, adjacent structures, overhead obstructions, site topography and security requirements.

1.05 SUBMITTALS
A. Fabricator shall submit, as a minimum, the following:
   1. Mill certificates for all steel members.
   2. Complete shop drawings, including placement plans, member sizes, connections, connection details, bill of materials, dimensions of members and locations of splices.
   3. All primers, coatings and cleaning methods.
   4. Submit shop drawings and calculations for all structural members signed and sealed by the qualified Registered Professional Engineer (licensed in Texas) responsible for their preparation.

PART 2: PRODUCTS

2.01 GENERAL

A. All steel shall be domestically manufactured, unless foreign sources are accepted by the University of Texas.

B. Primer paint shall be compatible with subsequent paint systems to be applied.

PART 3: EXECUTION

3.01 ERECTION

A. Prior to erection, erector shall check elevations of concrete and masonry bearing surfaces, locations of anchor bolts and similar devices before proceeding with erection. Report any discrepancies to U.T. project representative.

B. Erector is responsible for all temporary shoring and bracing.

C. Level and plumb individual members and steel frame to within AISC tolerances.

3.02 QUALITY CONTROL

A. The University of Texas will contract with an independent testing agency to provide inspection services during the course of the project. The fabricator and the erector shall provide access to all parts of the work for inspection by the testing agency to accomplish its work. The testing agency may require access to the fabricator’s shop at any time during fabrication or just prior to shipment of the steel joists and/or joist girders.

B. The University of Texas reserves the right to reject any and all materials or workmanship not complying with specified requirements at any time.

C. Fabricator and/or erector shall correct all deficiencies and work which is not in compliance with the specified requirements. Any additional testing or inspection costs will be at the expense of the fabricator/erector.

PART 4: DESIGN

4.01 GENERAL
SECTION 05200 – STEEL JOISTS & JOIST GIRDERS
CONSTRUCTION STANDARD

A. In the design of steel joist and joist girder systems, the design engineer shall take
into consideration the future flexibility of the system and the need to make
frequent modifications to building systems.

4.02 DESIGN

A. Refer to U.T. Structural Systems standard for design loads.

B. Live load reduction shall be in accordance with the U.T. Structural Systems
standard.

C. Deflections - Unless approved by the U.T. Structural Engineer, steel member
deflections shall be limited to the following:

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In addition, the engineer should give due consideration to the control of excessive
floor vibration and to the control of pounding on roofs. The engineer shall also
consider the affect of deflections on architectural finishes attached to the structural
members. In some cases, it may be necessary to provide greater stiffness than the
above deflection limits require.

D. Floor Slabs on Metal Deck – Floor slabs may be designed as either composite or
non-composite systems. The minimum slab thickness above the metal deck
should be at least 3 inches. It is preferable that the concrete thickness be increased
to provide any required fire separation rather than fireproofing the bottom of the
metal deck.

E. Lateral Forces – In the design of steel joist and/or joist girder systems for lateral
loads, the use of a braced frame is preferred in order to reduce the chance of
cracking in brittle finishes. The use of a Moment-Resisting Frame to resist lateral
forces is at the discretion of the U.T. Structural Engineer.

F. Full-Penetration Welding – Full-penetration welds are often required and even
desirable for many steel connections. However, the use of full-penetration
welding should be limited due to both cost and testing requirements. The engineer
should give consideration to these factors when designing steel connections.

G. Joist Bridging – All joist bridging shall be designed by the joist manufacturer.
Joist bridging shall conform to all OSHA requirements for erection stability.

4.03 SYSTEMS TO AVOID

A. Avoid steel joist systems with excessive span/depth ratios. Deflections should be
kept within acceptable limits.

B. Avoid the use of A-490 bolts.

C. Steel yield strengths greater than 50 ksi.

END OF STANDARD 05200
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of The University of Texas at Austin for metal items manufactured to conventional details from standard metal shapes and plates that do not fit specifically in other locations.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Refer also to Section 09950, Coating and Paint Systems for general guidance concerning the specific preferences of UT-Austin for exterior and interior coating and paint systems for brick, CMU, concrete, gypsum board, plaster, steel and stucco.

1.03 Quality Control

A. Galvanized metals: Accessibility, maintenance, and appearance each will govern the satisfactory use of galvanized materials. Coordinate design efforts through the UT project representative. Care must be taken to assure use with only compatible materials.

B. Fabricate assemblies that are to be galvanized into large sections as possible in the shop to minimize field welding and resultant coating.

1.04 General Requirements

A. Erosion resistant cement: Material compatibility to site conditions, environmental conditions, and also paint primer types shall all be considered in determining the need to use erosion resistant cement. Coordination of use shall be through the UT project representative.

B. Primer compatibility: Check coatings and paint systems for compatibility with specified or existing primer and manufacturer's recommendations for preparations prior to any new applications onto the primer. Follow paint or coating manufacturer's recommendations for primer installation/type and environmental conditions required for base material preparations, such as moisture content, drying time elapsed, ambient air temperature, etc. prior to any paint or coatings application.
C. Exterior fixed ladders shall meet OSHA requirements found in 29CFR 1910.27, with the exception that #6 rebar is not to be used. For ladder rungs use 3/4” A36 square steel welded at 90 degrees to center.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 05500
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for manufactured expansion joint assemblies, including frames, covers, and gaskets.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Expansion joints: Refer to Section 07940 JOINTING OF EXTERIOR VERTICAL SURFACES for expansion control recommendations at exterior vertical concrete and masonry joints.

B. Waterproofing expansion joints in horizontal surfaces of plazas and decks: Refer to 07050 Plazas and Decks.

1.03 Quality Control

A. A proper selection of design and materials for each individual condition will accommodate the anticipated movement of the building.

B. Considerations for a proper selection include determining the joint size. This must be determined by the project designing structural engineer. Also, the fire rating of the joint needs proper consideration and selection, and the exposure condition will govern the need for waterproofing details.

1.04 General Requirements

A. Expansion joint cover: The specific condition will determine the applicable selection. Coordinate the choice with the UT project Design representative. In remodeling projects, all expansion controls already installed must be retained, or replaced if necessary.

B. Waterproofing expansion joints in horizontal surfaces of plazas and decks: Avoid driving or dragging heavy equipment or materials over in place expansion joint assemblies.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 05800
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for wood foundations; framing, sheathing, and decking using timber, lumber, and engineered wood products. Blocking and supports to join members and anchor framework to other construction.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Quality Control

A. All older campus building should be thoroughly checked for termites and other insect infestations, and specifications should address treatment measures required if termites are found during renovation.

PART 2: PRODUCTS

2.01 General

A. Contractor shall provide UL label for fire retardant material.

B. Contractor shall provide certification for preservative treated material.

C. Lumber shall be kiln dried, bearing stamp of Southern Pine Inspection Bureau or equivalent agency.

D. Fire retardant treated lumber shall bear UL label.

PART 3: EXECUTION NOT USED

END OF STANDARD 06100
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for fine shop fabricated woodwork, requiring expert craftsmanship and joinery.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Refer to AWI “Premium” grade.

1.03 Quality Control

A. Types of wood in specific areas: In remodeling work, match existing. For new construction where there is no existing to match, use AWI “Premium” grade as the guideline.

B. Cabinet carcass material selection, typical storage shelving, fixed, adjustable: In no instance shall particleboard be used. Refer to AWI “custom” grade for preferred guidelines.

C. Grain matching: Book matched for any wall paneling and also where stained wood is used on door faces.

D. Visible connections: Refer to AWI “Premium” grade guidelines.

1.04 General Requirements

A. Color of paint/stain: The preferred finish is light in lieu of dark.

B. Plastic laminate preference: Refer to AWI “custom” grade. Installation shall be only on horizontal surfaces and countertop splashes. Plastic laminate shall not be utilized for facings on cabinet doors and drawers without prior approval. Installation where any off gassing will occur is not allowable in certain controlled environment. Contact the UT project representative for confirmation of these areas. Also, any requirement for chemical resistant laminate shall be clarified with the UT project representative.

C. Plywood shelving: Refer to AWI “Premium” grade. In areas other than janitorial, finish shall be a clear coating rather than solid color paint or plastic laminate. Coating shall be polyurethane type. Painted coatings may be utilized on shelving in janitorial areas.
D. Cabinet hardware –Hidden: Review proposals with UT Austin Project Representative.

E. Pre-finished woodwork/In-field finish: Provide pre-finished woodwork where possible. Where in-field finish must be performed, coordinate environmental concerns, ventilation requirements, shutdowns, etc. with UT Office of Environmental Health and Safety.

F. Delivery of woodwork to project: Any area where woodwork is to be installed shall have been satisfactorily conditioned for temperature and humidity control prior to introducing woodwork into the space.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 06402
PART 1: GENERAL

1.01 Scope of standard

The scope of this standard includes recommendations for the design and maintenance (retro-fit) of plazas and decks over occupied space(s). In general, plazas and decks over occupied space are not recommended.

1.02 Related Standards

A. Structural Systems (currently The University of Texas Office of Facilities Planning and Construction Owner’s Design Guidelines, Section K, Structural Criteria).

1.03 General Requirements

A. All plazas and decks situated over occupied space(s) shall have a redundant, bi-level drainage system to protect the occupied space(s) from water infiltration and damage.

1. The primary drainage system shall be at the top wearing surface exposed to weather and traffic.

2. Secondary drainage shall be provided below the wearing surface, at the membrane level, to drain any moisture that infiltrates down below the primary level protection at the wearing surface. The secondary drainage shall be provided by a pre-fabricated drainage grid, paver pedestals, or other method as required to provide free flow to the drains at the secondary level.

B. It is preferable to select a system that allows water to flow both on top of and below the wearing surface. Two systems that can be used separately or in a hybrid system are as follows:

1. An open joint system generally consists of individual paver units supported on pedestals with approximate 0.25 inch gaps between units.

2. A closed joint system generally consists of concrete surfaces or individual paver units with gaps filled with porous grout or sand, or the individual paver units placed in a lean mortar setting bed.

C. Paver units are preferable to large, monolithic concrete sections because pavers enhance drainage at the secondary level and long-term maintenance is simplified due to accessibility of the substrate (both the structural deck and the waterproofing system).
D. Provide a sloped substrate to insure adequate drainage at both the primary and secondary levels. Tapered insulation, sloped structural deck, variable pedestal heights, or other method(s) shall be used to accomplish this goal.

E. THE DESIGN OF PLAZAS AND DECKS SITUATED OVER OCCUPIED SPACE(S) SHOULD BE CONSIDERED EARLY IN THE DESIGN DEVELOPMENT OF A PROJECT SINCE THE EFFECT ON THE STRUCTURAL DESIGN AND OVERALL COST CAN BE SIGNIFICANT. The following items shall be considered in the design of plazas and decks situated over occupied space(s):

1. Slope of the structural deck (or if it currently is, in retro-fit applications).

2. Slope or contour of the wearing surface (or if it currently is, in retro-fit applications).

3. True clearance available between the substrate and the bottom of the wearing surface. At new conditions, this clearance should be optimized to assure proper drainage at the secondary level. In retro-fit applications, limitations may dictate the design of the overall system.

4. Type of drainage system and the limitations on drainage capacity.

5. Flashing at drains, rising walls, light pole supports, expansion joints, or any other feature that could effect overall adequacy of the drainage system.

6. Traffic and site feature loadings, as well as any possible pedestrian hazards caused by gaps between pavers, etc.

7. Aesthetics.

F. Walking surfaces shall be designed to be nominally level. Abrupt changes in elevation of walking surfaces shall not exceed ¼ inch. The slope in the direction of travel shall not exceed 1 in 20. The slope perpendicular to the direction of travel shall not exceed 1 in 48.

PART 2: PRODUCTS

2.01 Secondary Drainage Details

A. Secondary drainage shall be accomplished through the specification of one of the products indicated herein.
B. Insulation boards shall be a high density type that does not absorb moisture, have drainage slots scored in two directions into the bottom surface, and is able to withstand the superimposed loads without deflection, with resulting cracking, of the wearing surface.

2.02 Membrane

A. A liquid-applied membrane completely adhered to the substrate will isolate leaks at their source and provide an easier way to trace locations requiring maintenance.

B. The membrane shall be a hot-applied, rubberized compound dispersed in asphalt with mineral fillers.

C. In high stress areas (rising wall flashings, penetrations, etc.) provide fabric reinforcing.

2.03 Paver System

A. The paver support system shall consist of one of the following types, depending on the needs for maintenance, accessibility, and loadings:

   1. Individual pedestals constructed from high density polyethylene or blocks of high density foam board. Variable height pedestals may be required to provide the proper slope at the primary drainage level.

   2. Continuous support on a pre-fabricated drainage grid. Pre-fabricated drainage grids allow for fast and efficient drainage of water at the membrane level.

   3. Continuous support on a 1-2 inch pea gravel setting bed.

   4. Continuous support on high density insulation board (approximately 100-125 psi compressive strength) with drainage slots scored in two directions into the bottom surface.

   5. Rigid supports fabricated from precast masonry units. This method of support is recommended in areas where pavers could be subjected to high density loading.

B. Where smaller poured concrete sections are required and the resulting system is closer in nature to a paver system than to a purely monolithic system, the support system shall consist of one of the following types, depending on the needs for maintenance, accessibility, and loadings:

   1. Continuous support on a pre-fabricated drainage grid.
2. Continuous support on high density insulation board (approximately 100-125 psi compressive strength) with drainage slots scored in two directions into the bottom surface.

3. Continuous support on a 1-2 inch pea gravel setting bed.

4. The method specified shall provide for proper placement of the concrete without blocking flow of water to or through the secondary drainage level.

2.04 Monolithic Concrete System

A. Paver systems are preferred. However, in the following cases a monolithic concrete system may need to be utilized:

1. Insufficient clearance to allow for the required clearance between the wearing surface and the substrate (structural deck).

2. The required finish contour of the plaza or deck will not accommodate a paver system.

B. Where a monolithic system is required, the monolithic concrete sections shall be designed in such sizes as to be removable for future repair of the substrate, including jointed, sealed sections with lifting inserts, or other method as may accomplish this goal.

C. Where applicable and cost effective, a combination of paver support systems and monolithic support systems may be considered to minimize the amount of monolithic concrete.

PART 3: EXECUTION

3.01 Membrane

A. The membrane shall be constructed in the field by spreading the hot rubberized liquid over the structural deck to form a continuous, monolithic, seamless membrane completely adhered to the substrate.

3.02 Detailing

A. Detailing shall be in strict conformance with the manufacturer’s technical literature for the respective products.
B. Any products used shall conform to the waterproofing manufacturer’s recommendations and shall be supplied and installed in such a manner so as not to void or reduce the anticipated warranty. It is recommended that approval of the overall proposed design be obtained from the prospective waterproofing manufacturer(s) during the design development and final design processes.
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for impervious membranes, coatings, and other materials applied to walls, slabs, decks and other surfaces subject to continuous and intermittent hydrostatic pressure and water immersion; includes boards and coatings required for waterproof protection.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Refer also to the UT-Austin campus Section 07050 for recommendations for the design and maintenance (retro-fit) of plazas and decks over occupied space(s).

B. Refer also to the UT-Austin campus standard Section 03300 for Waterstops, Sealers, and Protective Coatings.

1.03 Quality Control

A. Protect work during construction. For below grade work use protection board and replace any board that is damaged during construction prior to backfill placement.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 07105
DAMPROOFING

PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for materials to provide resistance to moisture penetration through foundation walls and similar surfaces subject to high humidity, dampness and direct water contact, but not subject to hydrostatic pressures.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Quality Control

A. UT-Austin campus standards require that any dampproofing be compatible with the substrate or primer on which it is adhered. Also, verify compatibility of flashing material and adhesives with damp proofing materials.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 07160
PART 1: GENERAL

1.01 Scope of Standard
   A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for organic or inorganic insulation applied for thermal protection in walls, ceilings, attics, and crawl spaces, under concrete slabs on grade and at the perimeters of foundations.
   B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Related Standards
   A. Refer also to the UT-Austin campus standard Division 15 of this document for energy conservation guidelines mandated by the State of Texas for use at the UT-Austin campus.

1.03 Reference Standards
   A. Refer to the UT-Austin campus standard Section 07500.

1.04 General Requirements
   A. Roof: Minimum insulation value equal to wall insulation, but never less than R30.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 07210
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for batts, boards, block infill, etc.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Quality Control

A. Isolation for sound transmission shall isolate areas such as: Conference rooms, counseling rooms, classrooms, janitor closets, electrical closets containing transformers, toilets, meeting rooms, and other areas requiring confidentiality.

B. Project requirements may dictate having an acoustic consultant on the consultant team. Review acoustic issues with UT Austin early in project planning.

1.03 General Requirements

A. Methods to use shall incorporate sound attenuation blankets, full height drywall assembly to structural deck above ceilings, sound sealant, proper spacing of return air grills, sound transmission boots, etc.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 07213
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for exterior-surfacing systems that provide both thermal insulation and decorative/protective finish.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

PART 2: PRODUCTS

A. These systems are not approved for use at UT-Austin.

PART 3: EXECUTION – NOT USED

END OF STANDARD 07241
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for systems of conventional components assembled according to standard details, to form exterior infill panels and continuous cladding over several stories. Assemblies typically consist of framing, insulation, and substrates and finish surfaces.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Refer to Underwriter’s Laboratories (UL) Design guidelines for detailing and specifying.

B. Refer to specific material section for relevant reference standards.

1.03 Quality Control

A. All assemblies shall meet Master Plan requirements.

B. Masonry veneer walls: All backup support construction for masonry veneer walls shall be CMU. Obtain authorization from UT Austin prior to specifying metal stud wall framing to support masonry.

C. Fire stopping: All floor to floor, floor to roof and other fire rated assemblies as required by code must be installed properly in place within exterior wall assemblies. Refer to Underwriter’s Laboratories (UL) Design guidelines for detailing and specifying.

D. All assemblies shall be constructed to ensure that masonry cavities not extending to a continuous soffit or roof deck shall be capped with continuous masonry, stone, or cast stone elements.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 07480
PART 1: GENERAL

1.01 Scope Of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for roofing systems.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Related Standards

A. Structural Systems (currently The University of Texas Office of Facilities Planning and Construction Owner’s Design Guidelines, Section K, Structural Criteria).

B. Plazas and Decks. Section 07050

C. Jointing of Exterior Vertical Surfaces. Section 07940

D. The Secretary of the US Department of the Interior’s Standards for Rehabilitation.

1.03 Reference Standards

A. National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual

B. Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA) Architectural Sheet Metal

1.04 Quality Control

A. Roofing contractors shall be certified by the roofing system manufacturer as qualified to install the specified system and to receive the specified warranty.

B. A minimum of one-half day, on-site inspection by an independent quality control observer shall be provided for each day of roofing installation. Once a week, Observer shall submit to UT project representative, copies of his daily reports. Weekly reports shall also include photographs to document the relative completion of project and any specific details or items of concern.

1.05 General Requirements

A. Roof shall be historically accurate and shall be coordinated with Master Plan.
B. Always provide slope.

C. Provide minimum 6 inch diameter roof drains. Always provide cast iron, domed strainers at drains.

D. Entire assembly shall resist UL Wind Uplift I90.

E. Minimum insulation value equal to wall insulation, but never less than $R = 30$.

F. At vertical projections through roof, provide minimum 8” clearance between top of flashing and roof surface. Always provide cricket on uphill side of any projection that interferes with drainage.

G. It is desirable to avoid pitch pans. If a pitch pan cannot be avoided, provide gooseneck or hood over pan and fill pan completely with urethane pourable sealant.

H. At areas where frequent foot traffic will occur (mechanical units, particularly), provide walk pads. Path of pads shall follow most convenient route between roof access and destination.

I. Provide two-year contractor’s warranty in addition to manufacturer’s warranty.

PART 2: PRODUCTS

2.01 Built-Up

A. General

1. Provide 20-year manufacturer’s no dollar limit warranty on labor and materials.
2. All base flashing shall be granular surfaced modified bitumen.

B. Substrate: No lightweight fill shall be allowed.

C. Insulation: Provide minimum two layers of near equal thickness. Tapered layer shall not count as layer.

D. Systems

1. Four-ply Asphalt with Aggregate.
   a. Mop four plies Type VI fiber glass felts.
   b. Type III asphalt.
c. ASTM D 1863 aggregate.

2. Three-ply Asphalt and Rubber/SEBS (Styrene Ethylene Butadiene Styrene) Modified Cap Sheet.
   a. Mop two Type IV fiberglass felts.
   b. Mop one reinforced modified cap sheet (Stress-Ply by The Garland Co., or approved equal) with granular surface or cover with ASTM D 1863 aggregate in asphalt flood coat.
   c. Use Type III asphalt for all moppings and flood coat.

2.02 Tile

A. Substrate
   1. Shall be able to receive screw and withstand specified wind loading (see above). Specified in paragraph 1.05(c) of this section.

B. Underlayment
   1. “Peel and stick” Ice and Water Shield by W.R. Grace Co., or approved equal.
   2. Minimize ultraviolet exposure (maximum allowable shall be 30 days).

C. Nailers (if required)
   1. 2 X 4 No. 1 Southern Yellow Pine, CCA 40 treated “Wolmanized”©. Use 10’ lengths to minimize warping.
   2. Use galvanized or copper nails.

D. Tile
   1. Use full corner Spanish tile in blend to be sympathetic with other existing University of Texas roofs as manufactured by Ludiwici Roof Tile Co., or approved equal. Specifications shall include a proposed tile blend with a requirement for a mock-up and approval prior to ordering.
   2. Prior to ordering tile, install field sample at roof height of proposed blend for Owner’s approval.

E. Accessories: Use preformed accessories, i.e. bird stops, hip and ridge corners, etc. Always use bird stops.
SECTION 07500 - ROOFING SYSTEMS
CONSTRUCTION STANDARD

2.03 Shingles

NOTE: Shingles are not a standard roof on a University of Texas building. Special permission from the Owner is required prior to specifying shingles.

A. Provide minimum 3/4” plywood substrate.
B. Elk “Prestige” line shingles, or approved equal.
C. No wood shingles shall be allowed, except where historically required, i.e. Winedale.

2.04 Metal Roofing

NOTE: Metal roofs are infrequently used on a University of Texas building. Special permission from the Owner is required prior to specifying metal roofing.

A. Copper is first choice. If steel is used, provide 24 gage minimum with Kynar 500 finish, or approved equal, from manufacturer’s standard colors (exemption possible by special permission of University).

B. Provide standing seam, double-lock connections.

2.05 Urethane Foam

NOTE: Foam roofs are not used on University of Texas buildings except on odd shaped structures or in the very dry climate of west Texas. Special permission from the University is required prior to specifying foam roofing.

2.06 Sheet Metal

A. Counter flashing

1. Copper is first choice. If steel is used, provide 22 gage minimum. For exposed steel, provide Kynar 500 finish, or approved equal, from manufacturer’s standard colors (exemption possible by special permission of UT project representative). Metal not visible from ground or windows, may be galvanized.

2. No surface mounted counter flashing shall be allowed. Always provide reglet.

B. Scuppers/Gutters/Down spouts

1. General

   a. All detailing shall conform to SMACNA standards. (Refer to item 1.03.)

   b. Where architecturally acceptable, 16 oz. copper is preferred. If
steel (22 gauge minimum) is used, provide Kynar 500 finish, or approved equal, from the manufacturer’s standard colors, and galvanized if not visible. Match existing, where historical demands require.

2. Overflow Scuppers: Make exterior perimeter high and place overflow scuppers such that bottom of scupper is 1/2” above top of finished roof.

3. Scuppers and gutters as part of roof drainage system.
   a. Place crickets between scuppers.
   b. Provide conductor head with down spout at scupper or top of down spout.
   c. Where possible, connect all down spouts to underground storm drainage systems. If not, configure down spout so that it, and its discharge, drain away from base of building. Provide cleanout at base of down spout.
   d. Provide expansion joints in gutters.
   e. Avoid internal gutters.

PART 3: EXECUTION

3.01 General

A. Built-up
   1. Minimum 1/4” per foot slope.
   2. Install per manufacturer’s requirements.
   3. No torches nor kettles allowed on roof without special permission of UT project representative (a fire protection plan shall also be submitted with the request).
   4. When determining set-up location, keep well away from fresh air intakes on adjacent buildings (and existing buildings on re-roofs).

B. Tile
   1. Minimum 5” per foot slope.
   2. Minimize ultraviolet exposure of underlayment (maximum allowable should be 30 days).
3. Attach nailers to substrate with sheet metal strap. Screw strap to substrate.

4. Cover nailer (and straps) with continuous strip of underlayment.

5. Use chalk lines in three directions; vertical, horizontal, and diagonal.


7. Provide two nails per tile. Nail into holes preformed into the tile.

C. Shingles: Minimum 5” per foot slope.

D. Metal Roofing: Minimum 5” per foot slope.

3.02 Re-roofing

A. Inspect existing roof:

1. Core existing roof to verify conditions.

2. Determine whether pull-out testing is required.

3. If existing roof is mechanically fastened, determine how to remove roof and methods to repair substrate.

B. Test for asbestos, lead, and asphaltic substances whose removal may require abatement or special environmental considerations.
C. Inspect existing skylights and report to UT project representative whether it would be prudent to include skylight re-work with roof repairs. Likewise, for roof scuttle and other rooftop accessories.

D. Remove existing roof to substrate. Never remove more roof than can be dried-in prior to completion of day’s work or in the event of rain.

E. Provide for substrate repair/replacement in Base Bid (by assumed quantities or percentages, and unit prices, if necessary).

F. Replace all nailers. Provide unit prices with bid to allow existing nailers to remain if determined to be satisfactory.

G. Re-use of existing counter flashing is permissible if UT project representative agrees. Verify height of finished roof and include repairs to counter flashing in Base Bid. Re-caulk top of existing counter flashing where caulking exists.

H. Re-oakum all existing drains.

END OF STANDARD 07500
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for materials and products to prevent the spread of fire through openings in floors, walls and other building components.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Related Standards

A. Compatibility of materials: All fire stopping must be a UL approved assembly.

1.03 Quality Control


1.04 General Requirements

A. Labeling/identifying conditions for future modifications: On the above ceiling (concealed) surface of each side of all fire rated walls, stencil in red and with 6” lettering, the rating of the wall.

B. This labeling shall occur at 20’ intervals.

C. Asbestos: In no instance will any product containing asbestos be acceptable for use.

D. Fire Stopping assemblies must make a smoke tight and water tight seal.

PART 2: PRODUCTS - NOT USED

PART 3: EXECUTION - NOT USED

END OF STANDARD 07840
SECTION 07940 - JOINTING OF EXTERIOR VERTICAL SURFACES
CONSTRUCTION STANDARDS

JOINTING OF EXTERIOR VERTICAL SURFACES

PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for jointing of exterior vertical surfaces for the following materials:

1. Concrete
2. Masonry

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Related Standards

A. Structural Systems (currently The University of Texas Office of Facilities Planning and Construction Owner’s Design Guidelines, Section K, Structural Criteria).

B. The Secretary of the US Department of the Interior’s Standards for Rehabilitation.


E. Masonry Veneer (Second Edition), Masonry Institute of America.

1.03 Definitions

A. Construction joint

1. Construction joints shall be located where construction will be facilitated or where the lack of a joint could cause the lack of structural integrity in the completed structure.

2. Construction joints are theoretically undetectable in the completed structure and shall not cause any reduction in structural capacity or integrity.

B. Control joint

1. Control joints include expansion and contraction joints and are intended to provide for movement in the structure in order to “control” any possible movements that may have an impact on the structural integrity of the completed structure.

2. Control joints also act as construction joints.
3. Control joints are often referred to as movement joints.

C. Expansion joint
   1. Expansion joints are control joints that are designed to allow for the expansion of the concrete or masonry.
   2. Expansion joints also act as contraction joints.

D. Contraction joint
   1. Contraction joints are control joints that are designed to allow for the contraction of the concrete or masonry.

1.04 General Requirements:
   A. Jointing shall be integral with the architectural/structural design and detailing, not added at the end of the design process to satisfy minimum requirements.
   B. This standard gives some general guidelines for the locations and sizes of joints. However, jointing design is dependent on the materials selected, the makeup of the materials, environmental conditions, and the architectural/structural design and detailing. Factors to be considered are:
      1. Temperature effects.
      2. Shrinkage effects.
      3. Creep.
      4. Stresses caused by the architectural/structural design.
      5. Moisture effects.
   C. All expansion and contraction joints shall be shown and detailed by the Engineer or Architect.
   D. Critical construction joints shall be planned for and shown on the drawings, with guidelines for other construction joints specified in section 03300, Cast-in-place Concrete, to be prepared as a part of the contract documents. Other proposed construction joints as specified in section 03300 shall be submitted by the Contractor to the Engineer for review and approval during construction.

PART 2: PRODUCTS

2.01 Joint Sealant
   A. Unless otherwise required for specialized conditions, joint sealant shall be a moisture-cured, single- or multi-component (depending on the application and required expansion/contraction capabilities), polyurethane-base, non-sag, elastomeric sealant.
   B. Sealant depth-to-width ratio at the center of the joint shall be 1:2.
C. Allowable expansion/contraction of the joint shall be ± 25 - 50% of joint width, depending on the product capabilities.

D. Where applicable, provide a compatible sealant primer.

2.02 Backer
A. Joint sealant backer is required for all applications.
B. Unless otherwise required for specialized conditions, joint sealant backer shall be a closed-cell, polyethylene rod.
C. Where limitations prevent the use of a backer rod, specify a polyethylene, self-adhesive, bond-breaker tape shall be used.

2.03 Filler
A. Joint filler shall be specified to provide filling of the gap and to prevent displacement and improper location of the backer.
B. Joint filler shall be a continuous, non-bleeding material compatible with the joint conditions.

PART 3: EXECUTION

3.01 Construction Joints
A. Locate construction joints where anticipated stresses are low.
B. Before placing new material against the completed side of the joint, clean the joint thoroughly and specify a bonding agent, mortar, lean grout, etc., as required to meet the definition and function of a construction joint.
C. Structural reinforcing shall be 100% continuous across the joint.
D. Where applicable, waterstops shall be provided for watertightness.

3.02 Control Joints
A. Expansion joints
   1. Locate expansion joints to accommodate anticipated expansion at abrupt changes in the structure, where butting up to existing structures, and at least one corner of windows, doors, and other rectangular openings.
   2. The spacing of joints shall be contingent on the material’s capacity to sustain expansion without damage to the concrete or masonry (usually based on the amount of reinforcing).
   3. Structural reinforcing shall be discontinuous across the joint. Terminate reinforcing a minimum of two (2) inches from the faces of the joint.
   4. Smooth reinforcing dowels, properly detailed, shall be provided to prevent
movement out of the plane of the vertical surface and to provide for shear transfer (as required).

5. The minimum expansion joint width shall be 1/4”.

6. Expansion joints shall be sealed.

7. Where applicable, waterstops shall be provided for watertightness.

B. Contraction joints

1. Locate contraction joints to accommodate anticipated contraction, usually at a set spacing of between 15 - 30 feet.

2. The spacing of joints is contingent on the material’s capacity to sustain expansion without damage to the concrete or masonry (usually based on the amount of reinforcing).

3. Maximum structural reinforcing shall be 50% continuous across the joint. Terminate non-continuous reinforcing a minimum of two (2) inches from the faces of the joint.

4. Smooth reinforcing dowels properly detailed can be provided to prevent movement out of the plane of the vertical surface and for shear transfer across the joint if the normal reinforcing detailed is not adequate.

5. The minimum contraction joint depth shall be 3/4 - 1 inch.

6. Typically, contraction joints are sealed.

7. Where applicable, waterstops shall be provided for watertightness.

C. Control joints shall not abruptly terminate in the middle of a vertical surface. (For example, do not discontinue joints at parapets, but continue joints through the parapet.)

Concrete: The following guidelines are in addition to those noted above and refer specifically to concrete:

A. Contraction joints in concrete shall be installed according to one of the following methods:

1. Pre-manufactured strips that are set in with the concrete and removed during or after the curing process of the concrete.

2. Saw-cutting. To be effective, saw-cutting must occur as soon as possible after concrete placement. Many factors influence the timing of saw-cutting, including weather conditions, concrete mix design, curing, and time of placement. However, the following general guidelines shall apply:
   a. Hot/dry conditions. Saw-cut within 4-12 hours.
   b. Cool moist conditions. Saw-cut within 24 hours.
B. Contraction joints in concrete shall be provided at the following locations:
   1. At major changes in wall heights.
   2. At changes in wall thickness.

3.04 Masonry: The following guidelines are in addition to those noted above and refer specifically to masonry:

A. Expansion joints in masonry shall be provided at the following locations:
   1. Below shelf angles or structural frames supporting masonry walls or panels.
   2. Above masonry walls or panels abutting structural frames.
   3. At major changes in wall heights.
   5. At regular intervals, not to exceed 25’-0.”

B. Contraction joints in masonry shall be provided at the following locations:
   1. At major changes in wall heights.
   2. At changes in wall thickness.
   3. Above joints in foundations.
   4. At columns and pilasters.
   5. At one or both sides of wall openings.

END OF STANDARD 07940
DOOR AND HARDWARE
FACILITY SPECIFICATION GUIDELINE

Specification Sections 081100, 082100, 087100, 084100

Edit Date: 8/20/2010

The purpose of this document is to support the equivalence of door hardware specifications for the University of Texas. Products detailed herein are the standard of quality to be used on new projects and renovations. Exceptions would include owners request for continuations of existing systems: i.e. - Existing key system.

It is the intent of this document to provide guidelines for the architect’s specification section 08710, for product groups and the hardware schedule. These items are to be coordinated to meet the requirements of life safety codes, ADA requirements and applicable building codes.

All aluminum door hardware shall be provided in compliance with this specification guideline, and such shall be noted in sections 08710 and 08410.

Include the following as a preamble in the Door Hardware specification section 087100:

“Prior to installation of hardware, the general contractor shall contact the manufacturers’ representatives to arrange and hold a jobsite meeting to instruct and certify the installing contractors’ personnel on the proper installation of their respective products. Seminar shall be attended by installers of hardware (including electrical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedule, templates and physical product samples. Finish hardware shall be installed in accordance with the reviewed hardware schedule and manufacturer’s printed instructions.”

“Upon substantial completion the manufacturer’s representative(s) shall inspect and approve the installation of the products they represent. A comprehensive check list shall be provided to the owner, verifying proper function of change, master and grandmaster keys, cylinders, mechanical and electro-mechanical hardware, doors and frames. Any identified installation or product issues shall be directed to the attention of the Architect for the purpose of generating the final punch list.”
SPECIFICATION GUIDELINE
SECTION 081100 – HOLLOW METAL

Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Acceptable Manufacturers</th>
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<tr>
<td>Hollow Metal Frames</td>
<td>Curries Series Depends on Application</td>
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<td>CECO Series Depends on Application</td>
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<td></td>
<td>Steelcraft Series Depends on Application</td>
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Product Notes and Applications:

Interior Frames:
Profile: Depending on Application
Gauge: 16 @ openings up to and including 4’-0” wide
16 @ openings over 4’-0” wide
Steel: Cold-rolled steel
Welding: Continuous face welded, dressed and ground smooth, prime paint

Exterior Frames:
Profile: Depending on Application
Gauge: 16
Steel: A60 galvanized
Welding: Continuous face welded, dressed and ground smooth, prime paint

- Frames shall include shipping bar at bottom to insure frame integrity during shipping. All shipping bars shall be removed prior to frame installation. Install frames per manufacturers and SDI (Steel Door Institute) standards and instructions.
- Fire rated frames require metal applied label indicating rating designation.
- Reinforce frames for surface mounted hardware and cut-out, drilled and tapped to receive mortised hardware.
- Electrified Openings: Doors shall be pre-wired with sufficient number of concealed wires to accommodate electric function of specified hardware. Provide Molex type standardized plug in connectors to accommodate up to twelve wires.
SPECIFICATION GUIDELINE
SECTION 081100 – HOLLOW METAL
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Acceptable Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Curries</td>
</tr>
<tr>
<td></td>
<td>Series Depends on Application</td>
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<tr>
<td></td>
<td>CECO</td>
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<tr>
<td></td>
<td>Series Depends on Application</td>
</tr>
<tr>
<td></td>
<td>Steelcraft</td>
</tr>
<tr>
<td></td>
<td>Series Depends on Application</td>
</tr>
</tbody>
</table>

Product Notes and Applications:

**Interior Doors:**
Series: 707  
Gauge: 18  
Steel: Cold-rolled  
Edges: Seamless - tack weld, grind smooth, fill and touch-up paint

**Exterior Doors:**
Series: Depends on Application  
Gauge: 18 gauge  
Steel: A60 galvanized  
Edges: Seamless - Continuous weld, grind smooth, fill and touch-up paint

- Fire rated doors require metal applied label indicating rating designation.
- Doors shall be internally reinforced for surface mounted hardware and cut-out, drilled and tapped to receive mortised hardware.
- Electrified Openings: Doors shall be pre-wired with sufficient number of concealed wires to accommodate electric function of specified hardware. Provide Molex type standardized plug in connectors to accommodate up to twelve wires.
SPECIFICATION GUIDELINE
SECTION 082100 – Wood Door
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Acceptable Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Doors</td>
<td>Algoma</td>
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<tr>
<td></td>
<td>Eggers</td>
</tr>
<tr>
<td></td>
<td>Graham</td>
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<tr>
<td></td>
<td>MoHawk</td>
</tr>
<tr>
<td></td>
<td>Marshfield</td>
</tr>
<tr>
<td></td>
<td>VT Industries</td>
</tr>
</tbody>
</table>

Product Notes and Applications:

Construction: 5-ply
Core: Engineered Core @ non-rated and 20-minute rated openings
Mineral @ 45, 60 and 90-minute rated openings
Face veneer: As required by the project
Edges: Same as face veneer
Matching: Pairs within the same opening
Warranty: Lifetime of installation

- Finish shall be type TR-6 / UV cured catalyzed polyurethane.
- Pre-fit for opening size and pre-machine for hardware as specified.
- Fire rated doors require metal applied label indicating rating designation.
- Doors shall be internally reinforced for attachment of hardware.
- Electrified Openings: Doors shall be pre-wired with sufficient number of concealed wires to accommodate electric function of specified hardware. Provide Molex type standardized plug in connectors to accommodate up to twelve wires.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt Hinges</td>
<td>McKinney</td>
<td>Hager</td>
</tr>
<tr>
<td></td>
<td>TA2714 TA2314 T4A3786 T4A3386</td>
<td>Stanley</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ives</td>
</tr>
</tbody>
</table>

Product Notes and Applications:
- Interior wood doors.
- Interior and exterior hollow metal doors.
- Out swinging lockable doors shall have NRP hinges.
- Width of hinges shall be sufficient to clear trim and wall conditions as shown on the drawings.
- Size: 4 ½” x 4 1/2” for doors up to 3’-0” in width, 5” x 4 ½” for doors over 3’-6” in width. Provide heavy weight hinges (.180) at high traffic doors.
- *Electric Hinges: Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Locate electric hinge at center location. Provide mortar guard for each electric hinge specified. Provide Molex type standardized plug in connectors to accommodate up to twelve wires.
SPECIFICATION GUIDELINE  
SECTION 087100 – Door Hardware

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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pivots</td>
<td>Rixson&lt;br&gt;Doors up to 3’-0” wide and 7’-2” high:&lt;br&gt;Top Pivot 147 x 180 with ¾” Offset&lt;br&gt;Intermediate Pivot M19* with ¾” Offset&lt;br&gt;Doors over 3’-0” wide and/or 7’-2” high:&lt;br&gt;H147 x H180 Top Pivot with ¾” Offset&lt;br&gt;M19* Intermediate Pivot with ¾” Offset</td>
<td>Ives&lt;br&gt;McKinney&lt;br&gt;Or approved equal.</td>
</tr>
</tbody>
</table>

Product notes and applications:

- Provide (1) intermediate pivot for every additional 30” of door height over 60”.
- High traffic interior doors with panic hardware that are subject to extreme abuse: Use pivots.
- *Electric Pivots: Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Provide Molex type standardized plug in connectors to accommodate up to twelve wires.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
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<table>
<thead>
<tr>
<th>Item Description</th>
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<tbody>
<tr>
<td>Continuous Hinges</td>
<td>McKinney</td>
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<tr>
<td></td>
<td>MCK-12HD</td>
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<tr>
<td></td>
<td>MCK-305HD</td>
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<td>Pemko</td>
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<td></td>
<td>Roton</td>
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<tr>
<td></td>
<td>Markar</td>
</tr>
<tr>
<td></td>
<td>Ives</td>
</tr>
</tbody>
</table>

Product notes and applications:
- Exterior doors to have stainless steel guarded continuous hinge.
- All high traffic interior doors to have geared aluminum continuous hinges.
- All continuous hinges to have a lifetime warranty.

SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Acceptable Manufacturer and Catalog Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Transfers</td>
<td>Securitron [EPT]</td>
</tr>
<tr>
<td></td>
<td>Von Duprin [EPT-10]</td>
</tr>
</tbody>
</table>

Product notes and applications:
- Use at heavy use electrical openings to transfer power from frame to door. Provide at all electrical applications using continuous hinges.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flush Bolts</td>
<td>McKinney</td>
<td>Rockwood 555 / 557 Series Manual Flush Bolts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1842 / 1942 Series Automatic Flush Bolts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>570 Series Dust Proof Strike</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trimco 3913 / 3917 Series Manual Flush Bolts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3810 / 3815 Series Automatic Flush Bolts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3910 Series Dust Proof Strike</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LCN / IVES</td>
</tr>
</tbody>
</table>

Product notes and applications:

- Manual or automatic flush bolts as necessary for code compliance. Install with dust proof strike.
- Provide extended top rod for oversized doors when using manual flush bolts.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sargent</td>
</tr>
<tr>
<td>Cylinders and Keying</td>
<td>Other approved manufacturers: Schlage, Corbin Russwin and Yale</td>
</tr>
</tbody>
</table>

Product notes and applications:

- Please provide from one of the above listed. **NO SUBSTITUTION.**
- Cylinders to be keyed to an existing grand master key system **MUST MATCH EXISTING – NO SUBSTITUTION.**
- Keying requirements to be coordinated and completed at factory to protect the integrity of the system. Field keying will not be permitted and will be considered as just cause for rejection of supplier. All bitting lists must be approved by the Supervisor of Locks and Keys before they can be factory keyed. All keys must be delivered directly to the Supervisor or Assistant Supervisor of Locks and Keys. **NO KEYS WILL GO TO THE CONTRACTOR OR SUPPLIER. THIS WILL BE A CAUSE FOR REJECTION OF THE SUPPLIER AND A RE-KEYING CHARGE.**
- Substitution of foreign made cylinders or components will not be allowed and also will be cause for rejection of supplier.
- Furnish cylinders with construction masterkeying for use during the construction period.
- Removable or interchangeable core cylinders shall not be accepted.
- All newly provided keyways must be restricted.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locks and Latches</td>
<td>Sargent 8200 XXX</td>
</tr>
<tr>
<td></td>
<td>Other approved manufacturers:</td>
</tr>
<tr>
<td></td>
<td>Corbin Russwin ML2000 XXX</td>
</tr>
<tr>
<td></td>
<td>Yale AUG 8800 XX</td>
</tr>
<tr>
<td></td>
<td>Schlage L9000 XXX</td>
</tr>
</tbody>
</table>

Product notes and applications:
- Provide locks from one of the manufacturers listed. **NO SUBSTITUTION.**
- On an addition to an existing building, match existing. **NO SUBSTITUTION.**
- Mortise locks shall be used as standard of quality for all projects.

SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Acceptable Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Locks</td>
<td>Securitron</td>
</tr>
<tr>
<td></td>
<td>Locknetics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Acceptable Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Strikes</td>
<td>HES</td>
</tr>
<tr>
<td></td>
<td>Folger Adam</td>
</tr>
<tr>
<td></td>
<td>Von Duprin</td>
</tr>
</tbody>
</table>
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware

Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Sargent</strong></td>
</tr>
<tr>
<td></td>
<td>Series Depends on Application</td>
</tr>
<tr>
<td></td>
<td><strong>Corbin Russwin</strong></td>
</tr>
<tr>
<td></td>
<td>Series Depends on Application</td>
</tr>
<tr>
<td></td>
<td><strong>Von Duprin</strong></td>
</tr>
<tr>
<td></td>
<td>Series Depends on Application</td>
</tr>
<tr>
<td></td>
<td><strong>Yale</strong></td>
</tr>
<tr>
<td></td>
<td>Series Depends on Application</td>
</tr>
<tr>
<td></td>
<td><strong>Stanley</strong></td>
</tr>
<tr>
<td></td>
<td>Series Depends on Application</td>
</tr>
</tbody>
</table>

**Product notes and applications:**

- Provide exit devices from one of the manufacturers listed. **NO SUBSTITUTION.**
- Cross corridor doors / Interior: Use surface vertical rod exit devices as preferred securing device. To be used in conjunction with electromagnetic hold opens wired into the fire system.
- Exit device dogging: Keyed cylinder in rail shall hold latch retracted to allow door to function as push pull on exterior doors. Hex key dogging to be used on interior. Omit on fire rated doors and when width of door is too narrow.
- Exterior doors: Pull trims preferred.
- All exit devices finish to be determined by building design application.
- All exit devices equipped with electric latch retraction shall require no more than 1.25A during latch retraction and 150mA to maintain a dogged position.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
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</thead>
<tbody>
<tr>
<td>Removable Mullions</td>
<td>Sargent L980 Series</td>
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<td>Corbin Russwin 907BKM Series</td>
</tr>
<tr>
<td></td>
<td>Von Duprin KR9954 Series</td>
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<tr>
<td></td>
<td>Yale KRM200 Series</td>
</tr>
</tbody>
</table>

Product notes and applications:

- Types: Lockable, steel, key removable. Key is not required to reinstall the mullion.
- Provide multi wire connectors when electric or monitor strikes are used. This allows mullion removal without damaging electrical connections.
- Preferred method of securing exterior pairs of doors when using rim exit devices.
**SPECIFICATION GUIDELINE**  
**SECTION 087100 – Door Hardware**  
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push/Pulls</td>
<td>McKinney</td>
<td>Rockwood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70C Series Push Plates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF168 Series Door Pulls</td>
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<tr>
<td></td>
<td></td>
<td>BF15847 Series Push/Pull Bars</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trimco</td>
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<td></td>
<td></td>
<td>1001 Series Push Plates</td>
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<td>7191-3 Series Door Pulls</td>
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<tr>
<td></td>
<td></td>
<td>1660 Series Push/Pull Bars</td>
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<tr>
<td></td>
<td></td>
<td>Ives</td>
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</tbody>
</table>

**Product notes and applications:**

- Mounting methods to be concealed type wherever possible.
- Provide decorative thru bolts at free ends of push / pull bars and pulls when used with exit devices.
- Push plate size: 4” x 16” minimum, except when limited by door stile.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinators</td>
<td>McKinney</td>
<td>Door Controls International</td>
</tr>
<tr>
<td></td>
<td>Ives</td>
<td>600 Series</td>
</tr>
<tr>
<td></td>
<td>CSM Series Coordinator</td>
<td>Rockwood 1600 Series Coordinator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trimco 3094 Series Coordinator</td>
</tr>
</tbody>
</table>

Product notes and applications:
- Provide filler bars for total opening width, closer mounting brackets, carry bars, and special preparation for top latches where applicable.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
Substitutions or Alternates not permitted unless noted below.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door Closers</td>
<td>Sargent 351 Series</td>
</tr>
<tr>
<td></td>
<td>Corbin Russwin DC8000</td>
</tr>
<tr>
<td></td>
<td>LCN 4040 Series</td>
</tr>
</tbody>
</table>

Product notes and applications:

- Provide closers from one of the manufacturers listed. **NO SUBSTITUTION.**
- Closers shall have non-ferrous covers, heavy duty forged steel arms, and separate valves for adjusting backcheck, delayed action, closing and latching cycles and adjustable spring to provide sizes 1 through 6.
- Provide non-sized closers, adjustable to meet maximum opening force requirements of ADA.
- Provide drop plates, brackets, or adapters for arms as required to suit details.
- Mount closers on room side of corridor doors and inside of exterior doors. Where possible install closers on door for optimum aesthetics.
SPECIFICATION GUIDELINE
SECTION 087100 – Door Hardware
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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor Mounted Door Closers</td>
<td>Rixson</td>
</tr>
</tbody>
</table>

**Product notes and applications:**

- Consult factory catalog to determine product application.
- Floor Closers to have separate and independent adjustable valves to control closing speed, latch speed, and backcheck.
- Provide a 185 Series Quickspotter Installation Kit, by RIXSON to assist floor closer installation.
- Provide sealed closer kit for applications where water contact may occur.
## SPECIFICATION GUIDELINE
### SECTION 087100 – Door Hardware

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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection Plates</td>
<td>McKinney&lt;br&gt;Ives&lt;br&gt;KP50 Series&lt;br&gt;Protection Plates&lt;br&gt;EG01 Series Edge Guards</td>
<td>Rockwood&lt;br&gt;K1050 Series&lt;br&gt;Protection Plates&lt;br&gt;300 Series Edge Guards&lt;br&gt;Trimco&lt;br&gt;K0050 Series&lt;br&gt;Protection Plates&lt;br&gt;KE31-1 Series Edge Guards</td>
</tr>
</tbody>
</table>

**Product notes and applications:**

- **Size:** Kick plates 10” high, Mop plates 8” high, Armor plates 36” high.
- **Width:** 2” less door width (LDW) at single doors when mounted on push side. 1” LDW at pairs and when mounted on pull side.
- **Material:** Stainless steel 0.050” thick with countersunk holes, beveled four edges (B4E).
## SPECIFICATION GUIDELINE
### SECTION 087100 – Door Hardware

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<thead>
<tr>
<th>Item Description</th>
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<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead Stops / Holders</td>
<td>Sargent</td>
<td>Rixson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 Series</td>
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<td>900 Series</td>
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<td>100 Series</td>
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<td>1540 Series</td>
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</tbody>
</table>

**Product notes and applications:**
- Install overhead stops where conditions limit the use of wall stops and floor stops would be a tripping hazard.
- Use special template closers to allow offset arms for surface applied stops.

## SPECIFICATION GUIDELINE
### SECTION 087100 – Door Hardware

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<table>
<thead>
<tr>
<th>Item Description</th>
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<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall and Floor Stops</td>
<td>McKinney</td>
<td>Rockwood</td>
</tr>
<tr>
<td></td>
<td>Ives</td>
<td>400 Series Wall Stop</td>
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<tr>
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<td>441 Series Floor Stop</td>
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<td></td>
<td>490 Series Door Stop/Holder</td>
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<td></td>
<td>Trimco</td>
</tr>
<tr>
<td></td>
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<td>1270 Series Wall Stop</td>
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<td>1200 Series Floor Stop</td>
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<tr>
<td></td>
<td></td>
<td>1254 Series Door Stop/Holder</td>
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<tr>
<td></td>
<td></td>
<td>1000 Series Door Stop/Holder</td>
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</table>
### SPECIFICATION GUIDELINE
### SECTION 087100 – Door Hardware
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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Preferred Manufacturer and Catalog Series</th>
<th>Acceptable Alternative Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Holders</td>
<td>Sargent 1561 Series</td>
<td>Rixson FM-990 Series</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LCN SEM7800 Series</td>
</tr>
</tbody>
</table>

**Product notes and applications:**
- Wired to release upon activation of fire alarm. Verify required voltage.

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### SPECIFICATION GUIDELINE
### SECTION 087100 – Door Hardware
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<table>
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<tr>
<th>Item Description</th>
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<th>Acceptable Alternative Manufacturers</th>
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</thead>
<tbody>
<tr>
<td>Thresholds and Gasketing</td>
<td>McKinney</td>
<td>Pemko</td>
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<tr>
<td></td>
<td></td>
<td>2005_T Series Stop Threshold</td>
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<tr>
<td></td>
<td></td>
<td>S88D Series Smoke Gasket</td>
</tr>
<tr>
<td></td>
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Facilities Services  Page 19 of 20
Door and Hardware
Facility Specification Guideline
University of Texas
Austin, TX

SPECIFICATION GUIDELINE
SECTION 087100 – DOOR HARDWARE

Substitutions or Alternates not permitted unless noted below.

FINISHES AND BASE MATERIALS:

A. BASE METALS: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal 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.
DIVISION 08 - OPENINGS

Note: The overall Division 8 standards are under construction. The following sections are in effect.

08 71 00 DOOR HARDWARE

1. General
   A. Door hardware must balance aesthetics and function, with function taking priority.
   B. All elements of door hardware, including hardware, locks and security for all doors must follow UT Campus Standards, including security minimum standards. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to this Standard in all cases. However, unless there is adequate justification, these Standards will govern the design and specifications for projects on the UT Austin campus. No exceptions are permitted without written approval of all the following representatives: Door Hardware (PMCS), Locks & Keys (Facilities Services) and Security Control (ITS), inclusively referred to as the “Door Hardware Team,” and the UT Project Manager.
   C. Specialized finishes, keying or other unique elements to door hardware make it very difficult for ongoing maintenance, function and keying activities that will occur over the course of building occupancy. Any specifications that deviate from these standards and/or that have custom finishes, keying or other unique elements must be approved by the UT Project Manager in writing, prior to issuing the construction documents for bidding.
   D. Reviews are required by the Door Hardware Team at key project milestones. Drawings and specifications for milestone reviews must include, at a minimum:
      1) Design Development: For each door, Consultant must indicate the function of the room/lock, whether the door is fire-rated, whether the door is alarmed, whether there is a card reader, and must identify particular security requirements.
      2) 30% Complete Construction Documents: Consultant must indicate specific hardware information for each door, including manufacturer and model number, keyway, finish, etc.
      3) The Door Schedule and the Hardware Schedule must match. Door numbers must be identified for each Hardware Set. Only include Hardware Sets that are used on the current project.
   E. Comments provided by the Door Hardware Team at milestone project reviews must be documented and responded to by the Consultant. Responses must be returned to the Door Hardware Team for review and comment.
   F. Construction phase requirements:
      1) Conduct a Preconstruction Meeting for door hardware, locks and security. The Door Hardware Team must be invited and in attendance.
      2) Submittals:
         a. Manufacturer’s installation guidelines are a required submittal. All door hardware must be installed according to the manufacturer’s instructions.
         b. All door hardware, for all doors specified on a specific project, must be simultaneously submitted on a single hardware schedule. This requirement applies even if the hardware is being supplied by different subcontractors. It is the General Contractor’s or Construction Manager’s responsibility to coordinate and submit the information in the format required.
      3) Include the Door Hardware Team on field inspection participants’ lists during the construction phase, including regular project walk-thrus and Punch List walk-thrus.
      4) Door hardware, locks and security components must be Commissioned and approved by the Door Hardware Team prior to the Owner signing off on Substantial Completion. Reference the Functional Test for Security Access Control – Door Inspection for specific requirements.
2. Door Hardware
   A. Door hardware must comply with the requirements of and be installed in compliance with the NFPA 101 Life Safety Code, the version in force at UT Austin at the time the project is started.
   B. Doors with security requirements must be coordinated with the Door Schedule, hardware specifications, security details and electrical requirements. Use consistent nomenclature throughout the documents.
   C. At all student-occupied classrooms, provide a thumb-turn on the interior of the door that will lock the outside trim but still allow free egress in emergency situations.
   D. Finish
      1) Reference Campus Lock Standards – By Building.
      2) The finish color for new hardware should match the existing finish when being installed in an existing building.
      3) Do not use polished brass, unless required to match existing.
      4) Prefer brush type finish for all metals.
   E. Uniformity: All hardware products used within a single building should be by a single manufacturer. Reference the Campus Lock Standards – By Building for more information.
   F. Door Hardware Components
      1) Reference the Door & Hardware Facility Specification Guideline, produced and updated by the University of Texas at Austin’s Facilities Services department.
      2) Door Levers:
         a. Must be designed to return back to within ½-inch of the door face on which the lever is mounted.
         b. Use full mortised locksets rather than cylindrical.
      3) Stops: Do not use floor stops. Provide internal wall blocking at door stop locations.
      4) Kick/Mop Plates: Provide on the corridor side of all hollow metal and wood corridor doors.
      5) Mechanical Push Button Door Opener: Any door operated by a mechanical push button device must also be installed with a keyed building system override for access in the event the mechanical device fails.
      6) Magnetic Door Locks: not permitted without approval from the Door Hardware Team. Use electrified hardware.
      7) All door hardware must be delivered to the project site, with the exception of key blanks for the door cylinders. Key blanks must be delivered to the UT Austin Locks & Keys representative.

3. Keying
   A. All cylinders must be keyed as directed by a representative from the UT Austin Locks & Keys department, to a restricted key system.
   B. Without exception, all existing cylinders removed from any doors must be returned to the UT Austin Locks & Keys department.
   C. Equip locks with manufacturer’s special 6-pin tumbler cylinder, with construction master key feature.
   D. Mortise locks must follow the Campus Lock Standards – By Building document. Provide cylinders and locks from the same manufacturer, except for maintenance areas.
   E. Coordinate special keying for maintenance areas, including mechanical, electrical, telecom, elevator equipment and grounds irrigation room doors with the UT Austin Locks & Keys representative.
   F. Lock cylinder parts must be constructed from brass or bronze, stainless steel, or nickel silver. Keys must be nickel silver or brass.
   G. For large capital projects (CP), furnish the following:
      6 Grandmaster keys
      6 Master keys per each Master used
      2 Change keys per cylinder
      24 Construction keys (2 provided to the Locks & Keys department)
1  Bitting list
1  Hardware Schedule
1,000  Key blanks for each Master keyway used.
Attic Stock: 6% replacement cylinders, not to exceed 15 cylinders per project.

H.  Locks must be master keyed, keyed alike, cross keyed, or otherwise keyed as instructed in writing by the UT Locks & Keys representative, prior to placing the order with the manufacturer.
I.  Manufacturer’s keying schematic must be reviewed and approved by the UT Locks & Keys representative before keys are produced.
J.  All permanent keys must be delivered by the manufacturer directly to the UT Austin Locks & Keys department.
K.  All construction blanks must be returned to the UT Austin Locks & Keys department at project closeout.
09 00 03 GENERAL PROVISIONS

1. General
   A. For renovation projects, consider the building’s character and existing finishes. All material patches should blend as closely as possible. Some buildings on campus have an existing palette that must be matched. Coordinate with the UT Project Manager.
   B. Design reviews by the UT Project Manager and UT Interior Designer are required for all finish selections.
   C. All specified materials must have a demonstrated history in a similar institutional setting, with similar regularity of cleaning and maintenance, for at least five years.
   D. Color-through homogeneous materials are preferred.
   E. Avoid custom-designed colors and finish materials.
   F. Avoid material(s) that require routine sealing or significant specialized maintenance.
   G. Construction documents must clearly identify and note all finishes, including their extent of coverage.
   H. Stencil fire rating above ceiling at all fire-rated walls, in 6” high letters at 20’-0” on center.
   I. Coordinate requirements for attic stock with the UT Project Manager.
   J. All finishes must complete off-gassing prior to Substantial Completion.

2. Sustainable Design:
   A. The University promotes energy efficient green design, construction and building operations.
   B. Materials are to be selected and specified following UT Austin’s Sustainability Policy and the United States Green Building Council’s LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.
      1) Finishes should meet LEED Standard 4.2EQ (Indoor Air Quality).
      2) Finishes should not exceed VOC limits established by the South Coast Air Quality Management (SCAQMD) Rule 1113.
   C. All materials must meet UT performance standards.

09 20 00 PLASTER AND GYPSUM BOARD

09 21 13 Plaster Assemblies

1. When used at ceilings or soffits, provide access panels at regular spacing where required for access.

09 21 16 Gypsum Board Assemblies

1. Follow industry standard STC levels for different occupancy types unless specifically directed otherwise by the UT Project Manager.

2. Gypsum board should meet LEED Standard 4MR (Recycled Content).

09 23 00 GYPSUM PLASTERING – prohibited.

09 29 00 GYPSUM BOARD

1. Use fire-resistant gypsum board wherever ½-inch thick or greater gypsum board is used.

2. High traffic areas: use fiberglass-mat faced gypsum board.
3. Wet areas and/or tile backer board:
   A. Use cement backer board for tile.
   B. Avoid paper-faced moisture resistant gypsum board panels (“green board”).

09 30 00  TILE

1. Tile at floors:
   A. Porcelain tile is recommended.
   B. Restroom floors: Recommend 2”x2” tile pieces with matching cove base. Where possible, slope finished floor to drain over the entire room.
   C. Glazed or polished tiles are prohibited.

2. Tile at walls:
   A. Glazed tile is recommended.
   B. Restrooms: Provide ceramic tile finish at all walls, not only wet walls, to at least ±6’-0” above finish floor level, in whole tile increments. Leave approximately 12” (minimum) of painted gypsum board from the ceiling.

3. Grout:
   A. Use epoxy type grout meeting ANSI 118.3.
   B. Dark colors are preferred.

4. Adhesive:
   A. Tile adhesive should meet LEED Standards 4.1/4.2EQ (Indoor Air Quality), 4.2MR (Recycled Materials) and 5.1/5.2MR (Regional Materials).

09 50 00  CEILINGS

1. Review proposed ceiling types with the UT Project Manager. The University is open to a variety of ceiling solutions, with the following stipulations:
   A. All ceilings should be designed to be easily accessible for maintenance and other access requirements, such as future technology installations.
   B. Prefer 2-foot by 2-foot acoustical ceiling tiles.
   C. Restroom ceilings must be gypsum board with appropriate access panels.
   D. Prohibited: concealed spline ceiling support systems.

2. Ceiling tile should meet LEED Standards such as 1EA (Energy Performance), 4.2EQ (Indoor Air Quality), 2.3MR (Resource Reuse) and 5.1/5.2MR (Regional Materials), as appropriate for the Work.

3. Follow industry standard STC levels for different occupancy types unless specifically directed otherwise by the UT Project Manager.

09 53 00  ACOUSTICAL CEILING SUSPENSION ASSEMBLIES

1. Locations subject to moisture penetration or condensation: use stainless steel hanger wires for canopy or other suspension systems.
09 60 00 FLOORING

1. Public area flooring:
   A. Building entries: Provide permanent open grill entry way systems and walk-off areas protected from weather at exterior doors, or provide walk off carpet with metal trim as applicable.
   B. Elevator floors: prefer rubber tile; solid colors are discouraged.

2. Wet laboratories: use chemical resistant flooring.

3. Masonry flooring: not permitted if it has significant fill and/or requires routine sealing or significant specialized maintenance.

4. Flooring materials not permitted by UT Austin:
   A. Specialty flooring: bamboo, cork and laminate.
   B. Wood flooring, except at gymnasiums and certain other specialized areas.
   C. Medium-density fiberboard (MDF) as a wall base.
   D. Solid tile or sheet vinyl products except for specialized areas.

5. Flooring should meet LEED Standards such as 4.3EQ (Low-Emitting Materials), 4MR (Recycled Content), 5MR (Regional Materials) and 6MR (Rapidly Renewable Resources), as appropriate for the Work.

09 65 00 RESILIENT FLOORING

1. General
   A. Unit tile is preferred.
   B. Homogeneous color and pattern recommended.
   C. Solid colors are discouraged.
   D. Off-gassing must be complete prior to Substantial Completion.

09 65 13 Resilient Base and Accessories

09 65 13.13 Resilient Base

1. General
   A. Meet ASTM F 1861 Type TS rubber, continuous roll.
   B. Typically, use standard 1/8-inch thick by 4-inch high (minimum) cove base.
   C. Dark neutral colors are preferred.
   D. The following are not permitted, unless matching existing base in a renovation project, where the majority of the existing base is to remain:
       1) Straight base
       2) Preformed corners, except in certain circumstances.
       3) Light colors

09 65 13.23 Resilient Stair Treads and Risers

1. Integral rubber treads and nosings with separate risers are preferred.

09 65 16 Resilient Sheet Flooring

1. Heat welded seams and coved base may be required for specialized areas. Review with UT Project Manager.
09 68 00  CARPETING

1. Any existing carpeting removed for renovation must be recycled. Coordinate with the UT Project Manager.

2. Materials
   A. Prefer maximum 24”x24” modular carpet tile with structured back.
   B. Dark colors preferred.
   C. Use only carpet that meets or exceeds Green Label Plus, set by the Carpet and Rug Institute.
   D. Preferred construction:
      1) Textured/level loop.
      2) Patterned/graphic loop.
      3) Multi-level/textured pattern loop.
   E. Prohibited construction:
      1) Broadloom.
      2) Cut pile.
   F. Prohibited fiber: Olefin.
   G. Manufacturer requirements:
      1) Must have a minimum of 10 years in the production of modular carpet tile products as a “running line” part of product offerings.
      2) Specific carpet tile backing system(s) must have a manufacturer’s history of at least 5 years.
      3) Minimum 15 year manufacturer’s warranty covering: wear, edge ravel, tuft bind, delamination, and static control.

2. Off-gassing must be complete prior to Substantial Completion.

09 70 00  WALL FINISHES

1. General
   A. Use Type II, Class A materials.
   B. Selections should be able to withstand heavy duty commercial traffic, and be manufacturer-rated for the intended application.
   C. Wall and corner protection must be provided in public areas.

2. Wall materials not permitted at UT Austin:
   A. Medium density fiberboard (MDF) as any part of a wall finish.

3. Wall finishes should meet LEED Standards such as 4.1/4.2MR (Recycled Content), 5.1MR (Regional Materials), 6MR (Renewable Materials) and 4.1/4.2EQ (Indoor Air Quality), as appropriate for the Work. Off-gassing must be complete prior to Substantial Completion.

09 90 00  PAINTING AND COATINGS

09 91 00  PAINTING

09 91 23  Interior Painting

1. Use only paints and coatings that meet:
   A. Green Seal Standard/GS-11 for primers.
   B. Green Seal Standard/GS 03 for anti-corrosive and anti-rust paints.
2. Recommended Finishes
   A. Public spaces and trim: use semi-gloss finish.
   B. Private spaces: use eggshell finish.
   C. Prohibited: flat finish.

3. Paints and coatings should meet LEED Standard 4.2EQ (Indoor Air Quality). All off-gassing must be complete prior to Substantial Completion.
10 00 03 GENERAL PROVISIONS

1. General
   A. Design reviews will be coordinated by the UT Project Manager at regular intervals.
   B. All specified items must have a demonstrated history in a similar institutional setting.
   C. Avoid custom material(s) or material(s) that require significant specialized maintenance.
   D. Construction documents must clearly identify and note specialty items, including their locations and mounting information.
   E. Coordinate requirements for attic stock with the UT Project Manager.

2. Sustainable Design:
   A. The University promotes energy efficient green design, construction and building operations.
   B. To the extent applicable, specialty items are to be selected and specified following UT Austin’s Sustainability Policy and the United States Green Building Council’s LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.
   C. All materials must meet UT performance standards.

10 10 00 INFORMATION SPECIALTIES

10 11 00 VISUAL DISPLAY SURFACES

10 11 13 Chalkboards

1. Markerboards/Whiteboards are preferred over chalkboards, unless specifically requested by User(s).

2. Use porcelain enamel steel type.
   A. If Users request alternate type, review with UT Project Manager.

3. Provide blocking in wall where possible.

4. Accessories
   A. Provide a marker tray and “starter set” (including chalk and eraser) at Chalkboard locations.

5. If requested by Users, salvage existing Chalkboard(s) for reuse when renovating space.

10 11 16 Markerboards (Whiteboards)

1. Use porcelain enamel steel type.

2. If Whiteboard wallcovering is used for entire wall surface, other walls in the room should be a different tone or color.

3. Prefer not to use Whiteboards or Whiteboard wallcovering as a projection surface.

4. Provide blocking in wall where possible.

5. Accessories
   A. Provide a marker tray and “starter set” (including markers, eraser and cleaning solution) at Whiteboard locations.
6. Other types of “White Boards” may be approved; review with UT Project Manager.

10 14 00 SIGNAGE

      1. All signage must comply with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and the Texas Accessibility Standards (TAS).
      2. Exterior Wayfinding signage must also follow guidelines in the current UT Austin Campus Master Plan.
   B. Room numbering must follow UT Austin Room Numbering Standards and be reviewed and approved by the UT Project Manager.
   C. Signage using tritium as an illumination source is prohibited, unless an exception in writing is received from the UT EHS Department. Coordinate with the UT Project Manager.
   D. It is recognized that project conditions and requirements vary and that differences from the signage standards may be justified at times. Coordinate approval with the UT Project Manager.
   E. Various room types may require signage or information in addition to a typical room sign (for instance, Quiet/Lactation Rooms, laboratories, etc.). Provide acrylic wall-mount frames for these locations, capable of accommodating a sheet of paper sized 8-1/2” X 11” and mounted in portrait or landscape orientation. Coordinate requirements, including type and mounting heights and locations with the UT Project Manager.

10 20 00 INTERIOR SPECIALTIES

10 21 00 COMPARTMENTS AND CUBICLES

10 21 13 Toilet Compartments

1. Use ceiling hung toilet partitions where possible and/or structurally feasible.
   A. Where additional supports are required, such as at “L” shaped configurations or where one side is open, use posts to accommodate structural requirements. It is preferred the posts are as small as possible.

2. Use wall-mounted vanity panels at urinals.

3. Prohibited: Stainless steel toilet partitions and vanity panels.

10 22 00 PARTITIONS

10 22 19 Demountable Partitions

1. Only use manufacturers with proven track records in similar institutional settings.

2. Within the same setting, only use demountable partitions from the same manufacturer.

10 22 26 Operable Partitions

1. Do not use accordion type partitions. Paired panel type operable partitions preferred.
2. When Operable Partitions are used:
   A. Structural requirements must be clearly identified.
   B. Provide drywall partition sound attenuation assembly between the top of the operable partition and the building’s structural deck above.
   C. The minimal STC rating of an operable partition should match that of adjacent walls.

### 10 26 00 WALL AND DOOR PROTECTION

#### 10 26 13 Corner Guards

1. Provide in all public spaces, service areas and at specialty finishes.
2. Protect outside corners of gypsum board partitions in public corridors to minimum 36” height.
3. Prefer wall protection at chair rail height for public areas with moveable seating.
4. When clear acrylic corner guards are used, call for back-painting of guards to match wall color.

### 10 28 00 TOILET, BATH AND LAUNDRY ACCESSORIES

#### 10 28 13 Toilet Accessories

1. All toilet accessories must be selected and installed to comply with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and the Texas Accessibility Standards (TAS).
   A. Vendors’ literature often identifies products as meeting accessibility requirements. However, it is cautioned that wall projections, mounting heights, twisting requirements, etc. be evaluated for each accessory specified.
2. Provide and install toilet room accessories as follows:
   A. Review all proposed toilet room accessories with UT Project Manager.
   B. Hand Soap dispensers
      1) Use Owner-provided, Contractor-installed soap dispensers.
      2) Coordinate with Custodial Services, through the UT Project Manager.
   C. Paper towel dispensers
      1) Mount above semi-recessed waste receptacles, or specify dispensers that are integral to the waste receptacle.
      2) Prefer paddle-type.
      3) Use universal 8-inch core paper roll dispenser (non-proprietary) only.
      4) Flat fold towels prohibited.
      5) Electric hand dryers may be provided in addition to paper towels.
   D. Toilet paper dispensers
      1) Use universal 9-inch diameter twin jumbo roll dispenser (non-proprietary), lock required.
      2) Provide dispenser with mechanism requiring complete use of one roll of paper before switching to second roll.
      3) Note that a higher mounting height may be preferred for bottom-fed dispensers.
   E. Disposal boxes
      1) Use surface-mounted (partition or wall) with hinged lids in Women’s toilet rooms.
      2) Mount on same side of toilet compartment as toilet paper dispenser.
   F. Standard framed individual mirrors over each lavatory.
   G. Provide large trash receptacle near toilet room door.
H. Provide baby changing stations in Men’s and Women’s toilet rooms in all buildings that have a high public use and/or are open 24-hours per day.

3. Do not use the following accessories:
   A. Vending machines (feminine products, condoms, etc.).
   B. Toilet seat cover dispensers.

4. Coordinate the following toilet room items:
   A. Fixtures:
      1) Toilets: prefer wall hung.
      2) Urinals: use wall hung. Waterless urinals require UT Project Manager approval.
      3) Lavatories: use single standard wall-mount lavatory. Do not use counter-mounted lavatories.
   B. Provide key-operated hose bib under one sink.
   C. Provide a duplex power outlet near door, for custodial equipment.
   D. Provide floor drain with floor evenly sloped toward the drain. Avoid locating drain in accessible stall.
   E. Provide kick-down doorstop on toilet room door(s), unless the door(s) are fire-rated.

**10 40 00 SAFETY SPECIALTIES**

10 43 00 EMERGENCY AID SPECIALTIES

1. Eyewash and Safety Showers.
   A. Must be constructed and installed to meet the most current ANSI standard.
   B. Install in laboratories and other areas where hazardous chemicals are used.
   C. Equipment must be located within 10 seconds of unobstructed travel.
   D. Identify location(s) with a highly visible sign.
   E. Do not locate electrical outlets within 18 inches of an Eyewash or Safety Shower.

10 44 00 FIRE PROTECTION SPECIALTIES

1. Fire hose cabinets must be approved by the UT Fire Prevention Services (FPS) group.

10 44 13 Fire Extinguisher Cabinets

1. Prefer recessed or semi-recessed models.

2. Prefer brushed stainless steel finish.

10 44 16 Fire Extinguishers

1. Use fire extinguishers as approved by the UT FPS Department.
10 50 00  STORAGE SPECIALTIES

10 56 00  STORAGE ASSEMBLIES

10 56 13  Storage Shelving

1. Type and material based on project requirements.
   A. MDF prohibited.
   B. Consider structural requirements for anticipated loading.

2. Coordinate life safety clearances for sprinkler heads.

10 57 00  WARDROBE AND CLOSET SPECIALTIES

1. General
   A. Include requirements in project programming.
   B. Provide wall blocking.

10 70 00  EXTERIOR SPECIALTIES

1. General
   A. Reference UT Campus Master Plan and historic structures information when selecting.
   B. May require review by the Faculty Building Advisory Committee (FBAC).
   C. At spaces identified by the University as historically significant, any specified items must be appropriately selected to correspond to the existing aesthetic. The PSP is encouraged to consult with appropriate historic expertise where necessary.
   D. Requires UT Project Manager approval.

10 80 00  OTHER SPECIALTIES

10 81 00  PEST CONTROL DEVICES

1. Coordinate pest control devices (bird, bat, rodent, insect) with the UT EHS Department.
   A. PSPs should consider building design features to minimize pest habitation on or around buildings.
   B. Integrity of building envelope is a priority for the University. Coordinate proposed attachment methods with UT Project Manager.
   C. Prefer to not use electrified pest control solutions, if immediately accessible to humans.
   D. Deterrent manufacturer must be licensed in the State of Texas.
   E. Product and installation must be warranted for effectiveness.
10.81.00 Pest Control

1. Foundations and Slabs

1.1 Drainage Design

1.1.1 Provide ¼” slope at patio slabs, sidewalks, and driveways away from building.
1.1.2 Tamp backfill to prevent settling and slope final grade away from the foundation at a rate of ⅛” per foot over a minimum distance of 10 feet.

1.2 Reduce Moisture

1.2.1 Do not block foundation vents with shrubbery, mulch, or other landscaping materials. Maintain vent openings to crawl spaces.
1.2.2 Use a continuous, durable subgrade membrane sealed at all splices, perimeters, and protrusions in order to minimize foundation moisture problems. The membrane product selected should be specifically manufactured for use as a subgrade membrane and conform to ASTM E1745, latest edition, 0.1 perm maximum. Installation should conform to ASTM E1643, latest edition.

1.3 Prevent Pest Access

1.3.1 For any ground-level space (e.g. raised foundation crawl space) requiring foundation vents, specify corrosion resistant vent material (e.g. bronze) and a vent opening size smaller than the pest to be inhibited. For example, for typical ants and termites, use #50 bronze mesh between layers of ¾ to 1-inch mesh for durability. Building codes generally require mesh with maximum opening of 1/4 inch, which will block rodent access.
1.3.2 Foundation vents should be at least 150 mm (6 inches) above finished ground level.
1.3.3 For visual access the upper 100 mm (4 inches) of the edges of a slab should remain exposed at all times; it should not be concealed by masonry, timber, soil, paving, etc.
1.3.4 The vapor barrier underneath a slab should end no higher than the level of the finished soil or paving level. Slab formwork should include 100 mm (4 inches) of smooth faced timber around the top of the slab edge. The purpose of these construction details is to avoid indentations which allow undetected termite access.

1.4 Foundation Access

1.4.1 Provide 18” clearance beneath and 6” clearance between accessory structures and exterior wall coverings at decks, fences, patios, planters, and other accessory wood structures. If this clearance is not possible, construct accessory structures so that they are easily removable to allow inspection for termites.
1.4.2 Provide easily removable components to allow access to foundation for inspections.
1.4.3 In order to minimize entry of pests via joints, pour concrete patios as part of the main slabs.
1.5 Foundation and Slab Isolation

1.5.1 No cellulose-containing material (wood scraps, form boards, vegetation, stumps, large dead roots, cardboard, trash, and foreign material) should be buried on the construction site within fifty feet of any building, especially in areas with high termite pressure.
1.5.2 Fill material used around structures should be clean and free of vegetation and cellulose material.
1.5.3 Prior to concrete placement, clean all cellulose-containing material from cells and cavities in masonry units to inhibit termite colonization.
1.5.4 After all foundation work is completed, remove all loose wood and debris from the crawl space and within one foot of the perimeter of the building.

1.6 Termite Resistant Materials

1.6.1 Use steel posts for post and beam foundations, especially in areas with high termite pressure. The ends of the posts should be sealed at both ends with welded plates and the posts should be set in concrete foundations.
1.6.2 In areas of high termite hazard, avoid Exterior Insulation and Finish Systems (EIFS, commonly referred to as synthetic stucco).
1.6.3 In areas of high termite hazard, avoid subgrade foam insulation on the exterior of the foundation, or pre-formed closed cell foam foundation systems.

1.7 Foundation and Slab Joints

1.7.1 Minimize need for expansion joints when designing slabs. When expansion joints are used, inspection access should be readily available and the use of termite-resistant mesh should be considered. In one study, 83% of subterranean termites entering buildings came in through expansion joints in concrete slabs.
1.7.2 In order to minimize voids in concrete slabs, mechanically compact concrete with a vibrator when pouring a slab.
1.7.3 Cure concrete slabs slowly to reduce shrinkage and cracks. Moist curing periods should generally not be less than seven days. Consult a structural engineer for design standards.
1.7.4 Embed anchor bolts in slabs as the slab is poured. If additional anchors are necessary, use adhesive anchoring systems rather than expanding fasteners to avoid causing cracks.
1.7.5 For foundations and slabs up to about 50 feet in dimension, use liberal applications of topical curing compounds to decrease cracking.
1.7.6 For foundations about 50 to 100 feet in dimension, use adequate concrete reinforcing and proper concrete mix design, placement, finishing, and curing techniques. Additionally, use a shrinkage limiting concrete admixture.
1.7.8 Concrete slab foundations should be monolithic (floor slab integrated and poured simultaneously with footings). Unplanned construction joints should be minimized. In areas of high termite pressure any joints should be protected with mesh barriers or sand (graded stone) barriers. Mesh barriers should be laid on top of the vapor barrier and have a 15 mm accordion fold under the joint. Edges should be
turned up 25 mm to be cast into the slab. The accordion fold should be protected by a strip of vapor barrier material so that the concrete does not bond to the accordion fold. Alternatively, a mesh barrier with an accordion fold can be parged to the top of the slab. Sand barriers should be confined within a void adjoining the joint that is at least 75 mm deep and at least 50 mm wide. A retainer cast into the slab should be used to confine the sand particles.

1.8 Termite Shielding

1.8.1 If termite shields are used to reduce subterranean termite damage, they should be constructed of galvanized steel at least 0.5 mm thick; sheet copper at least 0.4 mm thick; stainless steel at least 0.4 mm thick; aluminum alloy at least 0.5 mm thick; copper and zinc alloys at least 0.5 mm thick; or woven stainless steel mesh. Joints and corners should be mitered and soldered, welded, or brazed. Shields should extend 70-80 mm past the foundation or foundation component. The last 30 mm of the shield should be bent downward at a 45 degree angle to reduce injuries during inspection. In addition, corners should be rounded. The slippery metal of termite shields provides a poor footing for termites and their tubes, although there is controversy about their effectiveness. They are perhaps most valuable for increasing the ability of inspectors to spot signs of infestation. The shields should be constructed by qualified professionals, with no gaps for termite access, and in settings that permit inspection.

1.8.2 When stainless steel mesh is used as a termite barrier, the mesh should be made from grade 304 or 316 wire with a minimum diameter of 0.18 mm. The maximum aperture size should be 0.66 mm x 0.45 mm. This maximum size should be reduced if local termite species are known to be small. As necessary the mesh should be parged to concrete foundations with a grout consisting of water-dispersed copolymer, Type GP Portland cement and sieved aggregate that can pass through the stainless steel mesh. The mesh should not contact dissimilar metals that will produce a corrosion reaction. If pieces of mesh need to be joined, the joint should consist of an area 10-15 mm wide where the edges of the two pieces are folded together 2 1/2 times or a parged area 35 mm wide where the pieces overlap. Mesh can be used as a perimeter barrier for masonry exterior walls when parged to the concrete slab, draped across the cavity, and then built into the exterior wall. It can also be used as a continuous barrier under concrete slabs, or as a barrier under joints and for utility penetrations.

1.8.3 Where graded particles (sand or basalt) are used as a termite barrier, the particles should be graded and shaped so that a sufficient proportion of them are of a size that cannot be transported by local termite species. They also should be able to be placed so that voids between particles to not permit penetration of local termite species. They can be either igneous or metamorphic stone. The wet/dry analysis must have less than 35% variation and their specific gravity must be at least 2.52. Graded particles can be used as a perimeter barrier when installed in wall cavities or in a trench around the foundation. In either case the minimum depth of the particles should be 75 mm. Trenches should be at least 100 mm wide. Graded particles can also be used as a continuous under-slab barrier. These barriers should be 75-100 mm deep and compacted with a vibrating plate-type tamper. Graded particles can also be used as a barrier under joints and around utility penetrations. Appropriate diameters for particles are 1.2-1.7 mm for the western subterranean termite, 1.7-2.8 mm for the eastern subterranean termite, and 1.7-2.4 mm for the Formosan termite.
1.9 Utility Penetration of Foundations and Slabs

1.9.1 Use epoxy immediately prior to pouring a slab to seal concrete around utilities.
1.9.2 Mesh barriers should consist of a flange of mesh 50 mm wide. The mesh flange should be attached to the penetrating utility with a stainless steel clamp and embedded in the slab. Alternatively, the mesh flange can be attached with a stainless steel clamp and then parged to the top surface of the slab.
1.9.3 For sand barriers, concrete should be poured in a circular area 25 mm around the utility pipe. That void should then be filled with sand at least 75 mm deep. See 1.9.3 for sand specifications. The sand should be capped at the top of the slab, and a retainer cast into the slab below the sand should be used to prevent sand loss beneath the slab.

1.10 Clearances

1.10.1 There should be a minimum clearance of 18 inches between beams or joists and soil.
1.10.2 In areas of high termite hazard, clearance between beams or joists and soil should be 36 inches.

1.11 Curtain Walls Where Necessary

1.11.1 Rodents may burrow under foundations of buildings without basements. Vertical curtain walls 2 feet (0.6 m) below the surface with an 8 inch (20 cm) horizontal "L" or flange directed away from the building are usually effective in preventing rats from burrowing under foundations. Construct curtain walls of 29-gauge corrugated iron, concrete, or bricks.

2. Siding

2.1 Siding Material

2.1.1 For wood siding, durable species include Western red cedar, Redwood, and (less commonly) Incense cedar, Port Orford cedar, Black locust, Northern white cedar, Eastern red cedar, and Alaska yellow cedar. Only heartwood of these species has resistant qualities.
2.1.2 Other pest-resistant siding options include fiber-cement, aluminum, and steel. Some of these materials may not be appropriate for residential structures.

2.2 Siding Installation

2.2.1 On siding, use high quality, exterior grade caulks and sealants that meet ASTM standard C-920. Caulk should be compatible with both siding materials and trim materials.
2.2.2 Caulk or seal the following areas: wherever siding meets trim, around windows and doors, and around any penetrations (pipes, wires, etc.) that are not self-flashing.
2.2.3 Use back flashing at siding butt joints to minimize openings that might allow entry of pests.
2.2.4 Siding and stucco should begin at least six inches above soil level. This decreases the risk of subterranean termites reaching the wood, and makes their mud tubes more visible to inspectors.
3. Building Exterior

3.1 Exterior Lighting

3.1.1 Choose light fixtures with sloping surfaces rather than horizontal surfaces to deter bird roosting and nesting.
3.1.2 Install bird spikes, "porcupine wire," netting, or similar devices to discourage birds from nesting on light fixtures.
3.1.3 Use bird exclusion devices, including wires, springs, nets, and electrical strips, to prevent birds from reaching light fixtures.
3.1.4 Motion detectors allow lights to be on for shorter amounts of time and can reduce accumulation of insects around lights.
3.1.5 Use timers to restrict light operation to high traffic times as appropriate. This may reduce the volume of insects attracted to the lights.
3.1.6 Use reflected light rather than direct light to illuminate doorways, as appropriate and allowed by local codes. Insects are more attracted to point sources of light and are therefore less likely to enter doorways.
3.1.7 Minimize direct lighting to high priority areas that maximize resident safety, especially near structures. All such lighting should meet local code requirements. This will minimize insect attraction to point source lights.
3.1.8 Use yellow lights ("bug" bulbs or sodium vapor lights, for example) in exterior areas where insect attraction to lights is an issue. Both intensity and color are important in insect attraction.

3.2 Miscellaneous

3.2.1 To minimize moisture accumulation, all downspouts and gutters should discharge at least one foot away from structure wall, using a connection to storm sewers, tail extensions, splash blocks, or dry wells.
3.2.2 Use gutters with downspouts on all buildings with eaves of less than 6 inches of horizontal projection except for gable ends and roofs above other roofs.
3.2.3 In areas of high rodent pressure, use flap valves to prevent rodents from entering downspouts. Mesh is also an option, but periodic cleaning will be necessary.
3.2.4 In areas of high rodent pressure, use cones or discs (typically metal) to prevent rodents from traveling up downspouts and pipes. Cones should be mounted with the wide end of the cone facing down and should be 12 inches in diameter and 12 inches long. Discs should be 18 inches in diameter.
3.2.5 Prevent mice and Norway rats from climbing on exterior vertical pipes by applying a 12 inch band of glossy paint around the pipe.
3.2.6 Use expanded strainer leaf guards (made for keeping leaves out of downspouts) to keep rodents from entering open pipes.
3.2.7 To discourage rodent burrowing, install a gravel strip of 1-inch (2.5 cm) diameter or larger, laid in a band at least 2 feet (60 cm) wide and 1/2 foot (15 cm) deep.
3.2.8 Maintain plants, grass, and mulch several inches away from the foundation of buildings to

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minimizing nesting sites for ants.
3.2.9 Design exterior landscaping so it does not cause moisture build-up around the foundation. Consider use of drip irrigation. Maintain clearances between vegetation and exterior walls.
3.2.10 Construct decks, fences, patios, planters, or other wooden structural components that directly abut the sidewall of the foundation or structure to provide: (a) an 18-inch clearance beneath the component, or (b) a 6-inch clearance between the top of the component and the exterior wall covering, or (c) have components that are easily removable by screws or hinges to allow access for inspection of the foundation sidewall.
3.2.11 Use termite-resistant fence and post materials, including naturally durable wood, concrete and steel.
3.2.12 Wood steps should rest on a concrete base at least 6 inches above grade to minimize access by wood-destroying pests, particularly in areas with high termite pressure.
3.2.13 Install quality 1/4 or 1/2 inch galvanized hardware cloth from the bottom of the shed/porch/decks without perimeter foundations to 3-4 inches below the ground and then out in a perpendicular fashion at least 12 inches from the vertical line. To improve appearance of hardware cloth used under sheds, decks, and porches, cover with lattice after installation.
3.2.14 Seal all holes or joints in exterior or other cavity walls that are larger than 1/4 inch diameter to prevent access by mice. Where larger holes or joints are necessary they should be screened with 1/4" mesh or otherwise shielded from pest intrusion. Seal smaller holes to eliminate access from smaller pests. Use caulk (non-elastomeric, does not return to original shape when stretched or compressed) for openings of 1/4" diameter or less. Use an elastomeric sealant to close larger openings. Use a liquid sealer to close pores and hairline cracks.
3.2.15 “Cap” concrete masonry unit walls by filling the top row of blocks with cement to eliminate rodent access to the interior of the wall.
3.2.16 For standard stucco weep-screed construction, seal along foundation with 6-inch minimum rubberized asphaltic, self-adhesive membrane extending down over foundation 1-2 inches. At point above screed section, also seal back of flashing to foundation with generous bead of foundation mastic. Use vinyl weep screed in corrosive environments.
3.2.17 For offset weep-screed installation use weep-screed flashing with offset in the flashing equal to actual framing offset. Install per standard weep-screed construction procedures except use 8-inch minimum self-adhesive membrane extending to bottom of weep-screed. Use small bead of caulking between base of framing and flashing.
3.2.18 Design exterior structures like decorative screens, moldings and lattices, siding, awnings, window sills, signs, fire sprinkler pipes, and column capitals so that they do not provide opportunities for bird perching, roosting, or nesting especially near building entrances. Use smooth materials and avoid horizontal surfaces. Where necessary, retrofit existing structures with exclusion devices (looped wires, sheet metal spikes, springs, nets, etc.), although these devices are not foolproof and require maintenance. Openings in buildings, exposed rafters on overhanging dock roofs, or any likely perches in semi-enclosed areas can be screened with rust-proof, 3/4 inch wire or plastic mesh, or 1/2 inch mesh to also exclude rodents. Plastic netting is less durable and must be replaced more often.
7.1 Use solid-core doors where possible. Solid-core doors are more durable and do not have hidden recessed areas or cavities that could harbor pests.
7.2 In areas of high rodent pressure, fit external doors with 26-gauge sheet metal kick plates 12 inches tall and mounted no more than 1/4 inch from the bottom of the door. Metal plates should not interfere with the swinging of the door.
7.3 Doors should fit tightly; the distance between the bottom of the door and the threshold should not exceed 1/4 inch. Use tight-fitting door sweeps if gaps are larger than 1/4 inch. If appropriate, use automatic door sweeps, which drop to seal against the floor when the door is closed. If automatic sweeps are not possible, bristle sweeps are preferable to rubber or plastic. If rodent pressure is high, protect rubber and plastic sweeps with metal kick plates installed on the outside of the door.
7.4 Specify air curtains (air doors) where doors are frequently open. Use models that start automatically when the door is opened to conserve energy. Properly installed and sized air curtains are typically about 80% effective in preventing insect entrance.
7.5 Use weather-stripping of all exterior doors to better seal against pest entry.

8. Windows

8.1 Slope smooth-surfaced window ledges and projections at 45 degrees to minimize bird perching and roosting.
8.2 Use weather-stripping for all operable windows.

9. Bedrooms

9.1 Moldings and joints around the room perimeter (floors, doors, cabinets, and windows) should be caulked with a silicone sealant to eliminate hiding spots for bed bugs.
9.2 Use wood, tile, linoleum, or similar flooring materials instead of carpets or rugs.
9.3 Built-in furniture provides harborage for bedbugs that is difficult to inspect. If built-in furniture is used, provide access for inspection.
9.4 Use leather, metal, plastic or laminate furniture rather than upholstered, wicker, or wood furniture. Metal and laminate furniture is harder for bedbugs to climb than wood furniture. If upholstered furniture is used, it should have metal legs and the fabric should be at least a few inches from the floor and from any other pieces of furniture. If possible, use furniture that is easily washable and light colored. Beds should not have headboards and mattresses should be encased in commercially available, insect-proof coverings.
9.5 Openings around pipes or other structures that come through walls, floors and ceilings should be sealed. Caulk, foam, seal, paint, or otherwise fill any cracks and holes larger than the thickness of a credit card.

10. Bathrooms

10.1 All penetrations of floors, walls, and ceilings should be sealed with metal escutcheon plates if feasible, or with polyurethane foam, silicone sealant, or other flexible sealant. Penetrations include electrical wires, supply and drain pipes, heating and ventilation systems, and recessed lights. Larger gaps may require the addition of copper or stainless steel wool to the foam, in order to effectively bar
access to rodents.
10.2 Countertops should be one piece if possible, that is, with an attached backsplash. If this is not feasible, use an elastomeric sealant to seal along edges of countertops and backsplashes where they meet walls.
10.3 Use one-piece tub or shower enclosures where they are appropriate with the bathroom design, to minimize potential infiltration of moisture.
10.4 In large shower enclosures, offset water controls so that they are close to the door. This makes them easier to use, and lessens the likelihood of water escaping the shower.
10.5 Slope horizontal surfaces of soap holders, shampoo cubbies, and shower seats so water drains into the shower or tub. This reduces moisture buildup.
10.6 Ensure horizontal ventilation ducts are sloped so that condensation water doesn't accumulate in the ducts.

11. Kitchens

11.1 Food storage should be elevated off the floor and away from walls to facilitate inspection and cleaning.
11.2 Wall-wall and wall-floor junctions should be coved to facilitate easier cleaning and prevent the accumulation of debris. Wall-ceiling junctions should be coved or sealed. Rubber or flexible plastic baseboard coving should be avoided, since it is very difficult to remove and inspect. Avoid cove base that is installed with adhesive. Choose coving that does not include an air gap under the curve, which could provide harborage for cockroaches.
11.3 Storage areas should have adequate lighting to allow efficient cleaning and easy pest inspection.
11.4 Provide access to voids above suspended ceilings for inspections and cleaning. In large buildings, provide walkways for this purpose.
11.5 Specify cabinets with legs to facilitate cleaning underneath. Legs should either be bolted to the floor with gaskets or sealant to eliminate gaps, or should be on wheels to enable easy moving.
11.6 Specify the use of wheeled stoves, mixers, refrigerators, and other appliances to encourage regular cleaning. Wheel fenders should include adequate clearance for cleaning around the wheels.
11.7 Locate drains so that they are accessible for cleaning.
11.8 When possible use flush thresholds in doorways. Thresholds collect dirt and food debris that can attract fruit flies or roaches.
11.9 When possible, locate food preparation areas on islands rather than against walls. Cleanup is generally easier around islands.
11.10 Install stainless steel backsplashes behind sinks and work surfaces for easier cleaning and avoid moisture buildup. Use sealant around edges.
11.11 Refuse disposal, recycling areas, and food delivery entrances should ideally be located away from frequently used entries. Refuse disposal and recycling areas attract flies and other pests, even when bins are well sealed and frequently cleaned. If the disposal area is adjacent to frequently used entries, such as those used for food deliveries, it is easier for the flies to enter the kitchen.
11.12 Use self-closing doors for food storage rooms to shut out rodents and some insect pests. Doors should be adequately sealed around the edges, with door sweeps or bottoms and no gaps over 1/4 inch.

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11.13 Seal all penetrations through walls and floors, including wiring and pipe penetrations through wall framing at top and bottom plates. Use either an elastomeric sealant or fire block, depending on the size of the gap, its location, and local building codes. This is especially important in institutional kitchens where there is no tolerance for pest infestations. For larger gaps, including copper or stainless steel wool with foam may be necessary to exclude rodents.
11.14 Any wall storage, ornamentation, signage, bulletin boards, etc. should be sealed using elastomeric sealant or hung at least 1/4 inch from the wall to discourage pest harborage.
11.15 If rodent pressure is high, design food storage rooms without double walls, false ceilings, enclosed staircases, boxed plumbing, and voids under cabinets. This permits easy inspection and removes harborage.
11.16 Avoid use of ceramic outside corner tiles. Ceramic tiles located in heavily used areas are highly prone to breakage. Broken tiles provide access to voids that can harbor pest insects. Durable outside corners, such as metal or plastic, are preferred alternatives.

12. Utilities, HVAC, and Chutes

12.1 Use escutcheons, cement mortar, or copper mesh or hardware cloth embedded in patching plaster to seal any openings around utility or HVAC penetrations.
12.2 Where rodent pressure is not high, or with gaps < ¼”, use silicone sealant to seal around utility penetrations to deter insect movement.
12.3 Outside air intakes or vents for wall-mounted heaters, air conditioners, and exhaust fans should be screened to exclude insects a variety of pests. Use 10-mesh screen or smaller and design/install the screen so that it can be easily removed for cleaning.
12.4 Use foam gaskets behind electrical cover plates to seal off access to pests, particularly in pest sensitive areas such as kitchens.
12.5 There should be adequate space and access for cleaning around utility penetrations.
12.6 Trash and laundry chutes should have tight-fitting doors. Avoid any gaps between door and surrounding wall.
12.7 Use metal garbage and laundry chutes with a circular cross section to avoid accumulation of debris in hard-to-clean corners.
12.8 Hopper doors into vertical trash chutes should be large enough to fit a full trash bag, to avoid the accumulation of debris from torn bags and keep chutes cleaner.

13. Refuse and Recycling

13.1 Design refuse and recycling areas with concrete pads that extend past the boundaries of the enclosure so that rodents cannot burrow into the enclosed area.
13.2 Enclose refuse and recycling areas with metal, concrete, or similar materials to prevent vertebrates from gnawing or climbing the enclosure. Enclosures should be solid and extend all the way to the ground. Do not plant ivy around enclosures.
13.3 Use refuse containers that are heavy duty, rust resistant, rat and damage resistant, and equipped
with tight-fitting lids. Racks or stands prevent corrosion or rusting of containers, reduce rat shelter under containers, and minimize the chance of containers being overturned.

13.4 Use concrete floors in refuse and recycling areas.
13.5 Slope floor of recycling and refuse area to a drain connected to the sanitary sewer.
13.6 Provide a hose bib near the enclosure for periodic cleaning.
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for parking gates, bumpers and barriers, electronic access and survey controls, signaling devices, admissions/collections equipment, vehicle detectors, lane controllers, etc.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

PART 2: PRODUCTS

2.01 Manufacturers

A. General

1. Parking Control Equipment - Amano Cincinnati Inc., an equal or better.

2. Parking Control Software - McGann Software Systems, an equal or better.

3. Access Cards - Cintac II compatible mag-stripe cards, an equal or better.

4. Access Cards – Amano Prox card PRX 120MD, an equal or better.

5. Access Cards – Amano Dual card 120MD, an equal or better.

2.02 Equipment/Components

Note: The equipment must function with UT-Austin’s mag stripe ID card. And must also have the capability to import access data to data files and be capable of operating any Parking Garage compatible computer programs in use at the time of bid.

1. Amano Cincinnati items:

   .01 Gates - model AGP-1700 or AGP-1710.

   .02 Detectors -
SECTION 11150– PARKING CONTROL EQUIPMENT
CONSTRUCTION STANDARD

Single detector - model ETP-134.
Dual detector - model AGP-0234.

.03 Ticket Dispensers – model ETP-12122 or ETP-22.

.04 Gate Arms - model AL20 Folding Aluminum.

.05 Pay Station - model AGP 7000.

.06 Fee Computer and Validator - model AGP-5200.

.07 Validator- model AGP-5600.

.08 -Fee Indicator- model AGP-5900.

.09 Card Reader-
model Mag1201-YL.

.10. “Lot Full” Signs w/pole and hardware - model LFSYL.

.11 -Card Reader Post.

12 -Converter - TC-Converter
RS232 to RS485.

.13 -Relays w/mounting bases (for gates)

.14 -Mag Stripe Tickets.

.15 -Mag Stripe Cards or Prox Cards.

.16 -L5 Amano Loops

.17 -Lag-time Exit Readers – model AGP-6000

.18 Aiphone Intercom - complete system

2. McGann Software System Items:

.01 Central Management System

.02 -Window Revenue Software - MPS1136W.

.03 -Windows Count and Monitoring Software – MPS4002W (4 lane
controller).

.04 - Window Access Control Software - MPS4002 - (with system code compatible to Cintac II cards currently in use at PGI).
.05 -Debit Card Module

.06 Integrated Mapping Module - MPS7010.

.07 IBM Compatible PC computer with printer, Pentium 4 Microprocessor, 1.4 GHz, 256MB SD RAM (133 MHz) 20 GB Hard Drive, 1 3.5 floppy drive, 1 CD/DVD combo drive, 2 USB ports (1 serial, 1 parallell), 56K modem, Windows 2000 RXP, PC Anywhere, 17” SVGA flat screen color monitor, IMSI PS/2 style mouse, keyboard, APC Power back-up, and plain paper color laser printer.

PART 3: EXECUTION - NOT USED

END OF STANDARD 11150
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for manual and automatic equipment for compaction and/or extrusion of various types of waste.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 General Requirements

A. Drainage

1. Floor of enclosure should have enough slope to allow rain water and other liquids to drain off without puddling.

2. The grade of the floor should direct run-off into landscaped areas rather than onto impervious surfaces.

3. If drainage is a threat of pollutant discharge to storm water, one of the following should be considered:
   a. Curb and diking, coupled with rainfall protection
   b. Routing rainfall protected storm drains to sanitary sewers
   c. Relocation of compactor

PART 2: PRODUCTS

PART 3: EXECUTION

END OF STANDARD 11172
LABORATORY RENOVATIONS

PART 1: GENERAL

1.01 Scope of Standard
   A. This standard provides general guidance concerning the specific preferences of The University of Texas at Austin for laboratory renovations.
   
   B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Related Standards
   A. 11700 – Fumehoods
   B. 11600 – Laboratory Equipment
   C. 01800 – Lead Based Paint Removal
   D. 02070 –Demolition & Renovation
   E. 02150 – Hazardous Materials Disposal
   G. 16513 – Fluorescent Fixture Disposal
   H. 15160 – Laboratory & De-Ionized Water Systems

1.03 General Requirements
   A. Certain laboratory equipment that could be contaminated with biological or chemical hazards, e.g., incubators, must be cleared through Environmental Health and Safety (EH&S) before they can be relocated to another lab or sent to Surplus Property. Laboratory renovations also often require the abatement or removal of hazardous materials. Contact EH&S at 471-3511 at minimum two weeks prior to any on-site work for requirements concerning the project.
   
   B. Contractors and University employees involved in the renovation must be trained about the hazards associated with the project, if their work might result in an exposure. The training may include, but should not be limited to personal protective equipment, personal hygiene, and emergency procedures.
C. In some instances, e.g., when perchloric acid was used in a fumehood system, the fumehood and duct will have to be washed down and decontaminated before removal procedures can begin. Other fumehood duct removal projects may involve special handling and disposal procedures. Contact EH&S for requirements.

D. If the renovation involves the shut down of fumehood systems, an outage has to be scheduled at least two weeks in advance. The University’s EH&S department, as well as all affected lab staff and the associated departmental office must be notified.

E. The Department of Public Safety, by means of a Memorandum of Understanding with the Texas Higher Education Coordinating Board, controls some lab apparatus, e.g., Erlenmeyer flasks. These controlled items cannot be discarded into the trash. If other lab staff cannot re-use these items, they must be transferred to EH&S for disposal. If unsure if glassware is regulated, contact EH&S for advice.

F. Fluorescent fixture disposal will be done in accordance with specifications found in Section 16513.

G. In some lab renovations, extra steps will be required to provide a safe work environment for contractors and University employees and to protect lab equipment from damage. These may include:

1. Cleaning or decontaminating surfaces prior to start of work.

2. Moving chemicals to a secure location such as another lab or into cabinets with closing doors. If cabinets with closing doors are not available, cardboard or plywood can be applied to shelving units to secure chemicals and prevent them from falling.

3. Moving lab apparatus and other materials from lab benchtops to secure areas, such as shelves or cabinets.

4. Moving or covering sensitive lab equipment.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 11500
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for safety equipment used in or in support of laboratories.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Related Standards

A. 11700 – Fumehoods
B. 11500 – Laboratory Renovations

1.03 Reference Standards

A. ANSI Z358.1-1998
C. OSHA 29 CFR 1910.106
D. OSHA 29 CFR 1910.1450
E. Centers for Disease Control (CDC)/ National Institutes of Health (NIH) Biosafety in Microbiological and Biomedical Laboratories, 4th edition
F. NSF 49 (most current version)
G. CRC Handbook of Laboratory Safety, 5th edition
H. Prudent Practices in the Laboratory, National Research Council

1.04 General Requirements For All Labs (chemical and biological)

A. Each laboratory shall contain a sink for hand washing.
B. The laboratory shall be designed so that it can be easily cleaned.
C. Laboratory furniture shall be capable of supporting anticipated loading and uses. Spaces between benches, cabinets, and equipment are accessible for cleaning.

General Ventilation

A. The general ventilation shall: be used for input to local ventilation devices; not be relied on for protection from toxic substances released into the lab; ensure that lab air is continually replaced, preventing increase of air concentrations of toxic substances during the working day; direct air flow into the lab from non-lab areas and out to the exterior of the building
B. When local exhaust systems such as hoods are used as the primary method of control, six to twelve room air changes per hour is adequate. (Ten – twelve room air changes per hour for moderate – high risk laboratories.)

Ventilation Devices
A. Fume hoods: Located 10 feet (minimum) from exit doors.
B. Exhaust air from glove boxes and isolation rooms shall be passed through scrubbers or other treatment before release into the regular exhaust system.
C. Biological Safety Cabinets must be constructed, installed, and tested in accordance with the current version of the National Sanitation Foundation (NSF) Standard 49.

Lab Benches
A. Provide for at least 40 – 48 inches of clearance between lab benches and everything else in the lab, e.g., other lab benches, walls, and fume hoods.
B. Epoxy resin counter tops – typical.
C. Provide Stainless Steel counters at locations with radioactive materials.
D. Bench tops shall be impervious to water and are resistant to moderate heat and the organic solvents, acids, alkalis, and chemicals used to decontaminate the work surface and equipment.

Emergency Showers and Eyewashes
The following requirements apply to both emergency showers and eyewashes:
A. The valve shall be designed so that the water flow remains "on" without requiring the use of the operator's hands (hands-free) and shall remain activated until intentionally shut off.
B. Valve shall be simple to operate and go from "off" to "on" in 1 second or less.
C. Equipment shall be in accessible locations that require no more than 10 seconds to reach from any laboratory work area.
D. Each location shall be identified with a highly visible sign.
E. Water shall be tepid, moderately warm.
F. Only potable water shall be used for eyewashes and showers.

**Emergency Showers**

A. The shower shall be located so that a water column is provided that is not less than 82 inches nor more that 96 inches in height from the surface on which the user stands.

B. Often, the best location for a shower is in the main corridor.

C. The center of the spray pattern shall be located at least 16 inches from any obstruction.

D. The shower shall be capable of delivering a minimum of 20 gallons of water per minute.

**Eyewashes**

A. An eyewash facility shall be readily available to all labs.

B. Eyewashes shall be installed close to the showers (in addition to other laboratory locations) so that, if necessary, the eyes can be washed while the body is showered.

C. The eyewash shall be positioned with the water nozzles 33 inches to 45 inches from the surface on which the user stands and 6 inches minimum from the wall or nearest obstruction.

D. There shall be no sharp projections anywhere in the operating area of the unit.

E. Eyewashes shall be designed to provide water to both eyes simultaneously, be a continuous flow design, and operate hands-free (although they can be actuated by hand).

F. Eyewashes shall be capable of delivering to the eyes not less than 0.4 gallons of water per minute.

G. Eyewash nozzles shall be protected from airborne contaminants and the protector cap's removal shall not require a separate motion by the operator.

H. Eyewashes shall be drained or be of the swivel type that allows the water to run directly into the sink. (Eyewashes shall be activated weekly to purge bacteria and debris from the water.)
Storage Units

Flammable Storage Cabinets

A. Flammable cabinets shall be specified for all labs that may use flammable chemicals in quantities greater than ten gallons.


C. Flammable cabinets are not required to be vented. Vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the manufacturer of the cabinet.

D. If vented, the cabinets shall be vented directly to the outdoors in a manner that will not compromise the specified performance of the cabinet and in a manner that is acceptable to The University Fire Marshall.

E. Flammable cabinets shall be marked in conspicuous lettering: "Flammable - Keep Fire Away."

Corrosive Cabinets

Corrosive cabinets shall be provided for labs that need to store corrosive material.

Base Cabinets for Fumehoods

A. Wherever possible, flammable storage cabinets shall be used as the base cabinets for fumehoods. If flammable storage cabinets are not used as the base cabinet, then the cabinet shall be constructed to withstand fire conditions so that the hood remains supported.

B. If vented storage cabinets are provided under the hood, they shall be vented in the following manner:

- do not cut the work surface for venting the base cabinets
- vent through the side wall of the hood with 1.5 to 2 inch national pipe thread (npt) galvanized pipe
- the tap into the exhaust shall be done above the hood
- the tap from the back of the cabinet shall be at the lower part of the cabinet and as supplied by the cabinet manufacturer
C. See attached Specification Sheet

Compressed Gas Cylinder Cabinets

A. Ventilated compressed gas cylinder cabinets shall be specified for labs which will use certain hazardous gases that are identified by The University, in larger than lecture bottle quantities (or where there are no fumehoods in which to store small cylinders). Refer to, www.utexas.edu/safety/ehs Environmental Health & Safety website, or EH&S at 471-3511 for a list of gases requiring ventilation.

B. Ventilated cabinets shall comply with International NFPA Standards Fire Code.

Lab Safe Refrigerators

A. If refrigerators are provided as part of the project, they will be Lab safe for labs that will utilize cold storage of flammable chemicals.

B. Refrigerators shall be manufactured as "lab safe," but need not be "explosion-proof."

Special Work Areas

Cold rooms and warm rooms shall have provisions for rapid escape in the event of electrical failure.

Biological Laboratories (only)

In addition to the equipment and design requirements described above, the following requirements are specifically for biological labs. (Refer to EH&S at 471-3511 to determine the appropriate biosafety level.)

Laboratory Facilities for Labs at a Biosafety Level 1

A. Each laboratory shall contain a sink for hand washing.

B. The laboratory shall be designed so that it can be easily cleaned.

C. Bench tops shall be impervious to water and are resistant to moderate heat and the organic solvents, acids, alkalis, and chemicals used to decontaminate the work surface and equipment.

D. Laboratory furniture shall be capable of supporting anticipated loading and uses. Spaces between benches, cabinets, and equipment are accessible for cleaning.

E. If the laboratory has windows that open to the exterior, they shall be fitted with fly screens.
Laboratory Facilities for Labs at a Biosafety Level 2
These are in addition to all of the requirements for Biosafety Level 1.

A. Chairs and other furniture used in laboratory work shall be covered with a non-fabric material that can be easily decontaminated.

B. Class II biological cabinets may be required (contact EH&S for assistance). If biological cabinets are used, install them in such a manner that fluctuations of the room supply and exhaust air do not cause the biological safety cabinets to operate outside their parameters for containment. Locate biological safety cabinets away from doors, from windows that can be opened, from heavily traveled laboratory areas, and from other potentially disruptive equipment so as to maintain the biological safety cabinets’ air flow parameters for containment.

C. An eyewash facility shall be readily available.

D. Illumination shall be adequate for all activities, avoiding reflections and glare that could impede vision.

E. There shall be an inward flow of air without recirculation to spaces outside the laboratory.

Laboratory Facilities for Labs at a Biosafety Level 3
These are in addition to all of the requirements for Biosafety Level 1 and Biosafety Level 2.

A. The laboratory shall be separated from areas that are open to unrestricted traffic flow within the building, and access to the laboratory is restricted. Passage through a series of two self-closing doors in the basic requirement for entry into the laboratory from access corridors. A clothes change room (shower optional) may be included in the passageway.

B. Each laboratory room shall contain a sink for handwashing. The sink is hands-free or automatically operated and is located near the room exit door.

C. The interior surfaces of walls, floors, and ceilings of areas where BSL-3 agents are handled shall be constructed for easy cleaning and decontamination. Seams, if present, shall be sealed. Walls, ceilings, and floors shall be smooth, impermeable to liquids and resistant to the chemicals and disinfectants normally used in the laboratory. Floors shall be monolithic and slip-resistant. Use coved floor coverings. Penetrations in floors, walls, and ceiling surfaces shall be sealed. Openings such as around ducts and the spaces between doors and frames shall be capable of being sealed to facilitate decontamination.
D. Windows in the laboratory shall be closed and sealed.

E. A method for decontaminating all laboratory wastes shall be available in the facility and utilized, preferably within the laboratory (i.e., autoclave, chemical disinfection, incineration, or other approved decontamination methods).

F. Biological safety cabinets are required and are located away from doors, from room supply louvers, and from heavily-traveled laboratory areas.

G. A ducted exhaust air ventilation system shall be provided. This system shall create directional airflow which draws air into the laboratory from “clean” areas and toward "contaminated" areas. The exhaust air shall not be recirculated to any other area of the building. Filtration and other treatments of the exhaust air are not required, but may be considered based on site requirements, and specific agent manipulations and use conditions. The outside exhaust shall be dispersed away from occupied areas and air intakes, or the exhaust shall be HEPA-filtered. A visual monitoring device that indicates and confirms directional inward airflow shall be provided at the lab entry. Consideration shall be given to installing an HVAC control system to prevent sustained positive pressurization of the lab. Audible alarms shall be considered to notify personnel of HVAC system failure.

H. HEPA-filtered exhaust air from a Class II biological safety cabinet can be recirculated into the laboratory if the cabinet is tested and certified at least annually. When exhaust air from Class II safety cabinets is to be discharged to the outside through the building exhaust air system, the cabinets shall be connected in a manner that avoids any interference with the air balance of the cabinets or the building exhaust system (e.g., an air gap between the cabinet exhaust and the exhaust duct). When Class III biological safety cabinets are used they shall be directly connected to the exhaust system. If the Class III cabinets are connected to the supply system, it is done in a manner that prevents positive pressurization of the cabinets.

I. Continuous flow centrifuges or other equipment that may produce aerosols are contained in devices that exhaust air through HEPA filters before discharge into the laboratory. These HEPA systems are tested at least annually. Alternatively, the exhaust from such equipment may be vented to the outside if it is dispersed away from occupied areas and air intakes.

J. The Biosafety Level 3 facility design and operational procedures shall be documented. The facility shall be tested for verification that the design and operational parameters have been met prior to operation.
Facilities shall be re-verified, at least annually, against these procedures as modified by operational experience.

K. Additional environmental protection (e.g., personnel showers, HEPA filtration of exhaust air, containment of other piped services and the provision of effluent decontamination) shall be considered if recommend by the agent summary statement, as determined by risk assessment, the site conditions, or other applicable federal, state, or local regulations.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION

Emergency Showers - Testing

When the shower is installed, test it in accordance with the following procedures:

A. With the unit correctly connected to the water source and the valve(s) closed, visually check the piping for leaks.

B. Open the valve to the full open position. The valve shall remain open without requiring further use of the operator’s hands.

C. Measure the shower. The face of the showerhead shall be not less than 82 inches nor more than 96 inches from the surface on which the user stands.

D. With the valve in the “full on” position, measure the diameter of the spray pattern. It shall be a minimum of 20 inches at 60 inches above the standing surface. The center of the spray shall be at least 16 inches from any obstructions.

E. Delivered water temperature shall be tepid.

Eyewashes – Testing

A. When the eyewash is installed, the valve shall be operated to determine that both eyes would be washed simultaneously at a velocity low enough to be non-injurious to the user.

B. Delivered water temperature shall be tepid.

END OF STANDARD 11600
12 00 00  FURNISHINGS

12 00 03  General Provisions

1. General
   A. Design reviews by the UT Project Manager and the UT Interior Designer are required for all furniture selections, and will be coordinated at regular intervals.
   B. All specified items must have a demonstrated history in a similar institutional setting, with similar regularity of cleaning and maintenance.
   C. Avoid custom material(s) or material(s) that require significant specialized maintenance.
   D. Construction documents must clearly identify and note specialty items, including their locations and mounting information.
   E. Coordinate any power requirements with electrical consultant.
   F. Coordinate requirements for attic stock with the UT Project Manager.

2. Sustainable Design:
   A. The University promotes energy efficient green design, construction and building operations.
   B. To the extent applicable, specialty items are to be selected and specified following UT Austin’s Sustainability Policy and the United States Green Building Council’s LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.
   C. All materials must meet UT performance standards.

12 05 00  COMMON WORK RESULTS FOR FURNISHINGS

12 05 13  Fabrics

1. Preferred characteristics:
   A. Pattern in darker colors.
   B. Protective finish/coating.

2. Avoid horizontal patterns on all seating.

3. Upholstery for auditoriums/public spaces
   A. Minimum 100,000 double rubs (Wyzenbeek).

4. Upholstery for all other spaces
   A. Minimum 50,000 double rubs (Wyzenbeek).

12 10 00  ART

1. General
   A. Reference the UT Austin Landmarks Program for art in public spaces.
   B. The PSP should coordinate with the UT Project Manager to provide documentation for supporting requirements for art, which may include:
      1) Drawings to identify location and structural support required.
      2) Accent lighting.
      3) Coordinate UV requirements.
12 20 00 WINDOW TREATMENTS

1. General
   A. Window treatments should be in harmony with the building exterior.
   B. Coordinate power requirements where motorized treatments are used.

12 21 00 WINDOW BLINDS

1. Do not use plastic blinds.
2. Prefer horizontal blinds over vertical blinds.
3. Mini blinds are acceptable; do not use micro blinds.

12 22 00 CURTAINS AND DRAPES

1. Limit use of draperies to specialty areas only.
2. Confirm fabrics meet fire codes.
3. Prefer specialty draperies are made locally.

12 30 00 CASEWORK

1. General
   A. All casework must meet applicable codes and standards.
   B. Specify manufacturer(s) with demonstrated experience with similar type projects in this or other institutions of higher education.
   C. Do not specify any casework that uses medium density fiberboard (MDF) or particle board as a substrate or finish material.
   D. Manufactured wood casework is preferred. However, the PSP is encouraged to:
      1) Consider other existing casework when specifying new casework in existing buildings.
      2) Consider User requests.
   E. Coordinate plumbing, electrical and data requirements with casework installation.

12 35 00 SPECIALTY CASEWORK

12 35 30.13 Kitchen Casework

1. Construct in accordance with the most current Texas Food Establishment Regulations (TFERs) related to kitchen equipment construction.

12 35 53 Laboratory Casework

1. Fabricate in accordance with the current standards of the American Woodworking Institute and within the guidelines of the Scientific Apparatus Manufacturers Association.

2. Provide under-cabinet or under-shelf lighting where casework is specified, unless requested otherwise by User.
12 36 00  COUNTERTOPS

1. Coordinate casework top finishes based on application (i.e., stainless steel, etc.). Epoxy resin tops are preferred in laboratories, unless the activities being performed in the laboratory warrant a different type top.

2. Do not specify materials for countertop(s) that require specialty maintenance.

12 36 53  Laboratory Countertops

1. Specific project design requirements will be reviewed to determine the need for acid and chemical resistant acrylic, chemical resistant solid phenolic plastic, acid resistant plastic laminate or standard plastic laminate countertops.

12 40 00  FURNISHINGS AND ACCESSORIES

12 43 00  PORTABLE LAMPS

1. General
   A. Do not specify lamp fixtures requiring halogen bulbs.

12 43 13.19  Floor Lamps

1. Do not specify torchiere-type free-standing lamp fixtures.

12 46 00  FURNISHING ACCESSORIES

1. Coordinate recycling container requirements with UT Project Manager and the UT Austin Sustainability Policy.

12 48 00  RUGS AND MATS

1. Reference Division 9 standards.

12 50 00  FURNITURE

1. General
   A. Wood tops (solid or veneer) prohibited.
   B. Prefer metal to metal connections.
   C. Specify caster and/or glide as appropriate.

2. New furniture purchases to meet LEED certification requirements. Options for meeting LEED requirements include Standard 4.5EQ (Indoor Air Quality), 2.3MR (Resource Reuse) and 5.1/5.2MR (Regional Materials). Furniture meeting 4.5EQ (Indoor Air Quality) should be GreenGuard Certified.
   A. All off-gassing must be complete prior to Substantial Completion.
12 52 00  SEATING

1. Prefer non-upholstered arms.
2. Conference chairs: prefer minimal adjustments.
3. Laboratory environments: use solid non-porous vinyl upholstery with a washable surface.
4. Refer to 12 05 13 Fabrics.

12 60 00  MULTIPLE SEATING

1. Meet all building and life safety code requirements.
2. Follow requirements set forth in the Americans with Disabilities Act (ADA) and Texas Accessibility Standards (TAS) regarding quantity and location of seating for disabled persons. In addition, provide a variety of seating widths to accommodate different body sizes.
3. All multiple seating specifications must be reviewed and approved by the UT Furniture Shop. Coordinate with UT Project Manager.
4. Stagger seating to aid with sightlines.
5. Floor mount only.
6. Seat and raceway construction must be steel or cast iron. Plastic is not permitted.
7. Coordinate with electrical consultant to provide power to a minimum of 10% of the seats in a multiple seating arrangement. Electrical and/or data outlets may not be mounted on any horizontal surface or in an orientation where the receptacles are facing up.
8. Prefer:
   A. Hard surfaced backs (shell), darker neutral colors.
   B. Arms: Non-upholstered.
   C. Seat upholstery: Vents required for breathability.
   D. Tablets:
      1) Plywood core with plastic finish and sealed edges.
      2) Must be integral to chair.
      3) Consider size to accommodate right and left hand requirements. Coordinate with UT Project Manager.
9. Refer to 12 05 13 Fabrics

12 64 00  BOOTHs AND TABLES

1. Design booths to include a non-upholstered crumb catcher element.
12 68 00  SEAT AND TABLE ASSEMBLIES
12 68 13  Pedestal Tablet Arm Chairs

1. Prefer:
   A. Hard surfaced backs (shell), darker neutral colors.
   B. Arms: Non-upholstered.
   C. Seat upholstery: Vents required for breathability.
   D. Tablets:
      1) Plywood core with plastic finish and sealed edges.
      2) Must be integral to chair.
      3) Consider size to accommodate right and left hand requirements. Coordinate with UT Project Manager.

2. Refer to 12 05 13 Fabrics.

12 90 00  OTHER FURNISHINGS
12 93 00  SITE FURNISHINGS

1. Site furnishings may require approval by the Faculty Building Advisory Committee (FBAC). Coordinate with UT Project Manager

2. Exposed metal parts should have a powder coat finish.

3. Specify furnishings with non-removable parts.
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of the University of Texas at Austin for prefabricated, pre-engineered buildings and structures assembled on temporary or permanent foundations, such as greenhouses, solariums, swimming pool enclosures, etc.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for UT projects.

1.02 Reference Standards

A. Refer to the UT-Austin campus standard titled “Pre-Engineered Metal Buildings” dated 5/14/98 for recommendations for the design, fabrication, and erection of pre-engineered metal buildings.

1.03 Quality Control

A. Design and construction documents for pre-engineered metal buildings shall be prepared and sealed by a structural engineer, registered in the State of Texas, familiar with local codes and design conditions. Design data and loading shall be clearly stated on structural documents.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF STANDARD 13120
PART 1: GENERAL

1.01 Scope of Standard

A. This standard provides general guidance concerning the specific preferences of The University of Texas at Austin for elevator and escalator basic requirements.

B. UT recognizes that project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification, it is expected that theses checklists will govern the design and specifications for UT projects.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

A. Elevator Check List, per ASME/ANSI A17.1

1. One smoke detector is required in each elevator lobby. Wiring from the detector is run to the elevator machine room to the elevator controller. Smoke detectors shall not be self-resetting. Primary and alternate zones for smoke detectors are required to provide the code required elevator alternate landing feature. Rule 211.3. Sprinkler required in pit of hydraulic elevators.

2. Metal pit ladder is to extend from the pit floor upward, not less than 42” above the bottom landing floor level. One ladder per elevator is required. Rule 106.1.

3. Pit light and switch shall be accessible and 42” above the bottom landing floor level. The pit convenience outlet shall be a GFI and mounted 48” above the pit floor. If sprinkled, NEMA 4 electrical apparatus required below four feet.
4. Machine room to be vented, if necessary, to maintain temperatures in the mid 80°’s F. Rule 101.5b.

5. Fused, padlockable mainline disconnect switch in machine room with feeder wires to elevator controller, all piped in accordance with N.F.P.A. and grounded. Disconnect switch must be in sight of the elevator machine and shall be the type that cannot be engaged with the door open. Rule 210.5. Shunt trip to be installed in disconnect or separate enclosure in the elevator machine room. A17.1 rule 102.2. If the elevator is a Hydraulic type, the mainline disconnect shall have auxiliary contacts to remove power from the battery lowering unit.

6. One (1) 120 volt, 20 amp, single phase power supply, fused padlockable disconnect in machine room and run to the elevator controller for the car light supply, for each elevator.

7. Provide an ADA compliant telephone or intercom in the elevator cab which is hooked up to a 24-hour maintained location. Rule 211.1. Provide phone in elevator machine room for communication with the elevator car.

8. Only elevator equipment is allowed in an elevator machine room. A sprinkler head is required in the machine room. There shall be a heat detector mounted within 2 feet of the sprinkler head and there shall be a smoke detector in the machine room. When hoistway and/or machine room sprinklers are provided, then an automatic disconnect for elevator power (shunt trip) must be provided. Rule 102.2. When the hoistway is sprinkled, it shall have a heat and smoke detector. If the hoistway is not sprinkled, there shall not be a smoke detector in the hoistway. For hydraulic elevators, a sprinkler head is required in the pit. If the sprinkler head is no more than two feet from the pit floor, no heat detector is required. All risers and returns shall be located outside the hoistway and machine room. Branch lines in the hoistway shall supply sprinklers at no more than one floor level.

9. Machine room door-B-labeled shall be self-closing and self-locking that can be opened from the machine room side without a key. Keys to unlock the machine room doors shall be readily accessible to authorized personnel, but not accessible to the general public. Rule 101.3d(4)
10. All fire sprinkler risers shall be located outside elevator hoistway. Rule 102.2.

11. Elevator hoistway shall be two (2) hour rated. Machine room(s) shall be rated for two (2) hour fire rating. There are exceptions to this rule, but it varies between areas. Rule 101.1a.

12. Pit shall be so designed as to prevent the entry of ground water and remain dry. A sump pump is required and the sump pump recess must have a metal grate cover that is substantially flush with the pit floor. The sump pump is to have a separate circuit with a non-GFI simplex receptacle for the pump plug-in mounted 48” above bottom of the Elevator shaft floor. Rule 102.2(5). The motor-rated switch for controlling the sump pump is to be mounted 42” (+6”-0”) above bottom landing floor level, adjacent to light switch. Label switch “pump”. The pump discharge piping is to be routed to a location near the pump switch (42” above bottom landing floor level). A hose bib is to be placed on the piping at this point. Valves (gate and/or check) are not required in discharge pipe; only a union is to be installed at the pump for disassembly by maintenance. The local alarm panel shall be located above pump switch (where Practical), shall have an alarm silence feature, and shall be powered from sump pump circuit at all times or other means. Switches and hose bib shall be located by ladder.

13. All machine rooms must have permanent lighting. (10 foot candle at floor). Rule 101.5.

14. Hoistway walls shall be substantially flush on hoistway side. Any offsets over 2” shall be provided with a beveled angle of not less than 75°. Rule 100.6.

15. Pipes, conduits, or ducts conveying air, gases, vapors, or liquids which are not used in connection with the operation of the elevator are not permitted in the hoistway or machine rooms. Rule 102.2.

16. Spaces containing machine, control equipment sheaves and other machinery shall be enclosed with fire-resistive enclosure. Enclosures and access doors thereto shall have a fire-resistance rating at least equal to that required for the hoistway enclosure. Rule 101.1a.
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CONSTRUCTION STANDARD

17. Grout space between floor and sill edge.

18. Patch any holes in the hoistway wall and “clip” all screws or other items projecting into elevator shaft.

19. Refuge space between top of car and structure is to be 43” minimum. Rule 300.8g.

20. Car number required in all cabs. (At least 1/2” in height) Rule 211.9d.


22. Ventilation of Elevator shaft required for all elevators 4 floors or more. Rule 100.4.

23. ALL hall button covers to have Appendix “H” pictograph with words: “In case of fire, elevators are out of service use exit”. UBC 3003.6.

B. Escalator Check List, per ASME/ANSI A17.1

1. SAFETY ZONE: The entry and exit zones shall be kept clear of all obstacles. The width of the zones shall be not less than the width between the centerlines of the handrail plus 8 in. (203mm). The length of the zone, measured from the end of the newel, shall be no less than twice the distance between the centerline of the handrails. These dimensions are absolute minimums and every consideration should be given to traffic patterns. Rule 802.6d.

2. The headroom shall be 7 ft (2.13 m) measured vertically from the step noseline, landing plates, and landings. Rule 802.12.

3. Rolling shutters, if used, shall be provided with a device which shall be actuated as the shutters begin to close to cause the electric power to be removed from the escalator driving machine motor and brake. Rule 805.3g

4. The interior of the escalator truss shall have a GFI duplex receptacle rated at not less than 15 A, 120 V, accessibly located, shall be provided under the
SECTION 14000 – ELEVATOR CHECKLIST
CONSTRUCTION STANDARD

access plates (Rule 806.3 at the top and bottom landing and in any machine areas located in the incline. Rule 806.1b.

5. The lighting of escalator landing floor plates and all exposed step treads shall be illuminated with a lighting intensity of not less than 5 ftc (54 lx). The illumination of these surfaces shall be of uniform intensity and not contrast materially with that of the surrounding area. Rule 806.2.

6. Reasonable access to the interior of the escalator shall be provided for the inspection and maintenance. Rule 806.3.

7. All electrical equipment and wiring shall conform to ANSI/NFPA 70.
PART 1: GENERAL

1.01 Summary:

1. This Section Includes:
   a. Hydraulic passenger elevator system.
   b. Hydraulic cylinder.
   c. Cab with doors, frames, and finishes.
   d. Hoistway doors and frames.
   e. Motor and pump, controllers, hoistway equipment, and accessories.

2. Related Sections:
   a. Section 01###-Construction Facilities and Temporary Controls: Temporary power supply.
   b. Section 03###-Cast-in-Place Concrete: Reinforced concrete shafts.
   c. Section 04###-Unit Masonry System: Masonry for fire rated shafts and hoistway openings.
   d. Section 05###-Structural Steel: Structural hoist, divider, and sheave beams and other steel items.
   e. Section 05###-Metal Fabrications: Pit ladder and accessories.
   f. Section 15###-Plumbing Fixtures: Pit drainage.
   g. Section 16###-Panelboards: Electrical power to the machine room including main switch and breaker. Heat and smoke sensing devices.

3. Work Required by Other Sections:
   a. The contractor shall coordinate all work required by latest applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
   b. The machine room shall be enclosed and conditioned per the elevator manufacturer’s required tolerances and have temporary power available for installation work.
   c. Crane service shall be provided for the hoisting of the machine room equipment.
   d. All structural beams and rails shall be in place.
   e. The elevator pit shall include ladder, guarded light, GFI receptacle and sump pump with cover. Light and pump shall be on separate dedicated circuits.

1.02 References:

1. American Architectural Manufacturers Association (AAMA):

2. American Society of Mechanical Engineers (ASME):
   b. A17.2.2: Inspector’s Manual For Elevators.
SECTION 14245 - HYDRAULIC PASSENGER ELEVATORS
CONSTRUCTION STANDARD


4. **American Society for Testing and Materials (ASTM):**
   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
   h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   i. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, General Requirements.
   k. B209: Aluminum-Alloy Sheet and Plate.
   l. B221: Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
   m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.

5. **National Electrical Manufacturer's Association (NEMA):**
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.

6. **National Fire Protection Association (NFPA):**

7. **Texas Department of Licensing and Regulation (TDLR):**
   a. Texas Accessibility Standards (TAS).

8. **Other:**
   b. AWS D1.1: Structural Welding Code.
   d. ANSI/IEEE 519: Electrical harmonic requirements.

1.03 **System Description**

1. **Characteristics of Elevator No. # as follows:**
   a. Type: Hydraulic; cylinder in buried casing.
b. Control: Microprocessor based static type that is software oriented.
d. Rated Net Capacity: #### lbs. (####kg).
e. Rated Speed: ### ft/min (#m/s), Full Load Up.
g. Cab Height: (#'-#").
h. Cab Clear Ht. to suspended ceiling: (#'-#").
i. Hoistway and Cab Entrance Frame opening size: (#'-#") x (#'-#")
j. Door Type/Operation: Select one: (Center Opening), (Side Slide) Select one: (Right Hand), (Left Hand) Select one: (Single Speed), (Two Speed).
k. No. of Stops: Number (#) stops; Travel distance: (#'-#").
l. No. of Openings: Number (#); (#) at front and (#) at rear.

2. Operation:
   a. Simplex Selective Collective.
   b. Duplex Selective Collective.
   c. Group Microprocessor Controlled Demand Allocation.

3. Programmable controls shall allow: When car without registered car calls arrives at floor where both up and down calls are registered, initially respond to hall call in direction of travel. If no car or hall call is registered for future travel in that direction, respond to hall call in opposite direction.

4. A hall lantern with an audible signal shall be installed at each landing entrance for each elevator. The lanterns, when illuminated, shall indicate the elevator car which shall stop at the landing and in which direction the car is set to travel.

5. Door Operation and Control Features:
   a. Furnish a direct current motor driven heavy duty operator. Operator shall be compatible with MCE Controller and adjustable without the use of proprietary tools. The system shall be designed to operate the car and hoistway doors simultaneously. Door movements shall be electrically cushioned at both limits of travel and the door operating mechanism shall be arranged for manual operation in the event of a power failure. A door protection system using microprocessor controlled infrared light beams (Janis or Microscan or equal) shall be provided. The beams shall project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen. A mechanical reopening device shall not be provided. Doors shall automatically open when the car arrives at the landing and shall automatically close after an adjustable time interval or when car is dispatched to another landing. Direct drive geared operators, A.C. controlled units with oil checks, or other deviations of these are not acceptable.

   b. If the electronic detector is activated when the doors are closing and the doors are more than one-third closed, they shall reverse direction and open only partially. The doors shall begin to reclose when the electronic detector is deactivated. The doors shall reopen fully if the electronic detector is activated longer than a fixed time.
c. **Nudging:** The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If the door movement is obstructed longer than a field programmable time value, a buzzer shall sound and the doors shall close at a reduced speed.

d. The current door hold time shall be changed to a shorter field programmable time when the door protection system is activated.

e. The microprocessor control system shall provide separate timers for car call door hold open time and hall car door hold open time. The door hold open times shall be field programmable.

f. Electric limit switches shall be placed in the hoistway near the terminal landings and be designed to cut off the electric current and stop the car should it run beyond either terminal landing.

6. The elevator shall be provided with a self-leveling feature that will automatically bring the car to the floor landings. This feature shall be entirely automatic and independent of the operating device and shall correct for overtravel or undertravel. The car shall be maintained level with the landing irrespective of the load.

1.04 Fireman's Service

1. Provide "Firefighter's Operation" in accordance with the latest ASME A17.1.

   a. Interconnect elevator control system with building fire alarm, and smoke alarm system.
   b. Designated Landing: Egress Floor.
   c. Seismic Design: In accordance with applicable code.

1.05 Independent Service

1. Provide "Independent Service Switch" in service cabinet in the car. Key activation will remove that car from normal operation and cancel all pre-registered car calls and hall calls for that car.

2. Car will respond to selected floor. Car will not respond to any calls from hall call buttons. Car will only respond to calls placed on the car operating panel. Doors will remain open at last landing requested. Doors will close with a constant pressure on "DOOR CLOSE" button.

3. Key activation to normal operation will return car to normal operation.

1.06 Emergency Operation

1. Battery or Auxiliary Emergency Power operated emergency return device to return elevator to the Egress Floor and open car and landing doors. Auxiliary (form "C") contacts are required to be incorporated in Shunt Trip, or fused type disconnects for emergency lowering device. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of (Form "C") contacts which shall change state when the electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts which shall close 0-50 seconds prior to any controlled change of the
emergency electrical system and shall open after the change. This input shall be
designed as the pre-transfer signal. This may not be used at the time of
installation of the equipment but must be available for future use.

2. When normal power is restored, automatically return elevator to normal operation.

1.07 Submittals for Review

1. Provide a signed copy of The University of Texas ENVIRONMENTAL
HEALTH AND SAFETY CONSTRUCTION SITE PROCEDURES FOR
CONTRACTORS, prior to commencement of any work

2. Submit under provisions of Section 0####:

   a. Shop Drawings: Include following information :

      1. Motor, hydraulic pumps, valves, controller, selector, governor, and other
         component locations.
      2. Car, machine beams, guide rails, buffers, and other components in
         hoistway.
      3. Rail bracket spacing and maximum loads imposed on guide rails requiring
         transfer to structure.
      4. Individual weight of principle components and load reactions at points of
         support.
      5. Loads on hoisting beams.
      6. Clearances and over travel.
      7. Locations of components in machine room. Show arrangement so that
         moving elements and other equipment can be removed for repairs without
         disturbing other components. Arrange equipment for clear passage through
         doors and access doors.
      8. Location in hoistway and machine room of connections for car light and
         telephone.
      9. Locations of access doors, doors, and frames.
     10. Expected heat dissipation of elevator equipment in machine room.
     11. Electrical characteristics and connection requirements.

   3. Samples: Illustrate cab interior finishes and car and hoistway door and frame
      finishes.

1.08 Submittals At Project Closeout

1. Section 0#### - Contract Closeout: Procedures for submittals.

2. Furnish two copies of bound maintenance manuals for each elevator. Include full
   maintenance and operating instructions, parts list, recommended spare parts,
   emergency parts inventory, sources of purchases and wiring diagrams.

3. Include legible schematic of hydraulic piping and wiring diagrams of installed
   electrical equipment and changes made in the work. List symbols corresponding
   to identity or markings on machine room and hoistway apparatus.
4. Provide one copy of master electric and hydraulic schematic and one copy of lubrication chart.

1.09 Quality Assurance

1. Perform Work in accordance with the latest ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section

2. Fabricate and install door and frame assemblies in accordance with NFPA 80 and UL 10B.

3. Qualifications:
   a. Manufacturer:
      1. Maintain a warehouse and maintenance service in the City of Austin, Texas.
      2. Minimum (5) years, prior to bid date of this project, in the business of providing elevator service and having warehouse facilities.
      3. Maintain in Austin, Texas an adequate stock of parts for emergency and replacement purposes.
      4. Qualified personnel available at Austin, Texas to insure fulfillment of maintenance and/or repair service on a 24 hour emergency call basis.

   b. Installer: Employees and supervisor on payroll of elevator equipment manufacturer.

   c. Equipment: Manufactured and guaranteed by the selling company; manufactured in its entirety (exclusive of cabs and doors) by the designer and manufacturer.

   d. Parts, accessories, and appurtenances: Erected, installed, adjusted, tested and placed in operation by competent mechanics skilled in this work and under the direct control and supervision of the Installers experienced foreman.

1.10 Regulatory Requirements

1. Conform to the latest ASME A17.1 code for manufacture and installation of elevator system.

2. Conform to State of Texas Accessibility Standards for provisions for the disabled.

3. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

1.11 Warranty

1. Section 0#### - Contract Closeout.

2. Correct defective Work within a one year period after Date of Substantial Completion.

3. Warranty: Include coverage for elevator operating equipment and devices.
4. Sealed jack assembly: 20 year unconditional warranty. Jack packing is excluded from this warranty.

1.12 Maintenance Service

1. Provide service and maintenance of elevator system and components for (90) Ninety-Days from Date of Final Acceptance of last elevator.

2. Provide service and maintenance of elevator system and components for one year from Date of Substantial Completion.

3. Examine system components monthly. Clean, adjust, and lubricate equipment.

4. Include systematic examination, adjustment, and lubrication of elevator equipment; maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.
   a. Include monthly Fire Service, battery lowering and emergency light Inspections and test.
   b. Include Hoistway sills and Car sills.
   c. Include elevator cab handrails.

5. Perform work without removing cars during peak traffic periods.

6. Maintain in Austin, Texas an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24 hour emergency call basis for this maintenance period.

7. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer.

8. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

1.13 Extra Materials

1. Section 0#### - Contract Closeout.

2. Supply three extra keys for each keyed switch.

3. Supply hand held computer and other proprietary components necessary to test and maintain elevator and equipment. Include updates or modifications of test equipment for 10 years.

PART 2: PRODUCTS

2.01 Manufacturers

1. Contract Documents are based on (List Model #) by (List Company).

2. Equivalent products by the following are acceptable:
a. Motion Control Engineering  
b. Thyssen/Dover  
c. KONE, Inc.  
d. Tejas Elevator  
e. United Technologies Otis Elevator Company  
f. Schindler Elevator Corp.  
g. Elevator Products Corp.  
h. Innovation Industries Corp.  
i. Hollister Whitney Elevator Corp.  
j. PTL Car & Hall Fixtures  
k. Owner approved equal  

3. Substitutions: Under provisions of Section 0###.

2.02 Materials  
1. Steel:  
   b. Sheet: ASTM A 446, galvanized, stretcher leveled, Commercial Grade.  

2. Stainless Steel: ASTM A 167, Type 302 or 304.  

   a. Extrusions: ASTM B 221.  

4. Plywood: APA Structural I, Grade C-D, sanded.  

5. Plastic Laminate: NEMA LD-3, General Purpose Type.  

6. Paints:  
   a. Primer for steel: Red Oxide. (NO LEAD)  
   b. Primer for wood: Alkyd primer/sealer.  
   c. Enamel: Semigloss alkyd.  

2.03 Components  
1. Motors, Pumps, Valves, Regulators, Fluid Tank, Hydraulic Fluid, Controller, Controls, Buttons, Wiring, Devices, and Indicators: As required by NFPA 70.  

2. Power Unit (Oil Pumping and Control Mechanism):  
   a. Pump and valves: Specifically designed for elevator application; the pump shall be of the positive displacement type. Pump/valve assembly shall be suspended within the oil reservoir by a rubber isolated suspension system to allow easy removal of components without draining oil from the reservoir. A silencer shall be install integrally in the oil reservoir interior. The design shall be such that the silencer shall contain no degradable parts. Where pump/valve
assembly requires location outside of reservoir, drip pan under entire unit shall be provided.

b. **Oil Control Valve:** shall contain in a single housing; high pressure relief valve; check valve; automatic unloading up start valve; lowering and leveling valve and magnetic control. Welded manifolds with separate valves to accomplish each function will not be permitted.

c. **Motor:** Designed for oil-hydraulic elevator service, of standard manufacture, and of duty rating to comply with specified speed and load. Motor rating for the number of starts per hour shall be suitable for the expected use of the elevator (minimum 120 starts per hour).

d. **Relief valve:** Externally adjustable and capable of bypassing the total oil flow before the pressure exceeds 150 percent of the working pressure and that the system will withstand this pressure. The relief valve to be pre-set to open at a pressure not greater than 125 percent of working pressure. The size of the relief valve and by-pass shall be sufficient to pass the maximum rated capacity of the pump without raising the pressure more than 20 percent above that at which the valve opens.

e. **Up Start and Stop Valve:** Externally adjustable and designed to bypass oil flow during start and stop of motor pump assembly. Valve shall close slowly, gradually diverting oil to or from the jack unit, insuring smooth up starts and up stops.

f. **Oil Viscosity Control:** When the oil temperature drops below the optimum operating temperature means shall be provided to maintain the proper viscosity of the oil.

3. **Guide Rails, Spring Buffers, Attachment Brackets and Anchors:** Purpose designed, sized according to ASME A17.1 Code with safety factors.

a. SPECIAL CONDITIONS: Remove the existing 15 lb. guide rails and store. To be reinstalled on this project at a later date. (Repaint).

4. **Jack Unit:**

a. Designed and constructed in accordance with the applicable requirements of the ASME A17.1 Code; Sized to lift the gross load to height specified; Factory tested to insure adequate strength and freedom from leakage; No brittle material, such as gray cast iron, shall be used in the jack construction.

b. **Components:**

1. Plunger: Heavy seamless steel tubing accurately turned and polished.
2. Stop ring: Electrically welded to plunger to positively prevent plunger leaving the casing.
3. Accessories:
4. Internal guide bearing, packing or seal of suitable design and quality.
5. Drip ring around cylinder top.
6. Cylinder constructed of steel pipe and provided with a pipe connection and air bleeder.
7. Brackets: Welded to the jack cylinder for supporting elevator on pit channels.

c. Provide required cylinder hole for hydraulic jack complete with an outer steel casing per ASME A17.1 and an inner watertight schedule 40 PVC casing.

5. Operational Controller:

a. Motion Control Engineering Inc. (MCE) Only. Controller shall be NEMA 1
b. Drive Control: PHC


a. (LS-QUTE)

2.04 Electrical System Characteristics

1. Electrical Characteristics:

a. 

b. 

2. Motor: NEMA code letter G or as required for torque and duty requirements. (#) hp motor @ (#) rated load amperes. Class F insulation rating.


2.05 Electrical Components

1. Boxes, Conduit, Wiring, and Devices: Required by NFPA 70 and under provisions of Division 16.

2. Fittings: Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. Spare Conductors: Include 10 percent extra conductors and two pairs of shielded audio cables in traveling cables. Do not parallel conductors to increase electric current capacity unless individually fused.

4. Do not use armored flexible metal conduit as a grounding conductor.

5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine rooms. Provide additional components and wiring to suit machine room layout.

6. All labeling required by ASME A.17.1 shall be of permanently engraved/embossed and permanently affixed plaques. Plaques may be either plastic laminate or metallic. "$Permanent Marker$" or "$Labeling Tape$" ID's shall not be used.

2.06 Lubrication
1. **Grease Fittings:** For lubricating bearings requiring periodic lubrication.

2. **Lubrication Points:** Visible and easily accessible.

### 2.07 Car Structural Fabrication

1. **Frame:** Fabricated steel frame of formed or structural steel shapes, gusseted and rigidly welded.

2. **Platform:** Fire retardant treated plywood subflooring assembly laid over steel stringers and ready to receive floor finish. The platform shall be completely isolated from the car sling and bracing members by vibration absorbing materials.

3. **Sling:** Shall consist of heavy steel stiles, properly affixed to a steel crosshead and safety channels with adequate bracing members to remove all strain from the car enclosure.

4. **Car Guides:** Rubber faced, spring loaded roller guides of suitable size for a smooth quiet operation.

### 2.08 Cab Fabrication

1. Based on (List Model #) Laminated Panel Cab manufactured by (List Manufacturer).

2. **Cab Design:** Passenger Elevator:
   a. **Flooring:** Rubber flooring as specified in Section 0####.
   b. **Sides and rear walls:** Plastic laminate.
   c. **Handrails:** Stainless steel, cylindrical profile, on rear wall.
   d. **Front and rear returns and transom:** Stainless steel with No. 4 finish.
   e. **Ceiling:** Translucent suspended.
   f. **Canopy:** Baked enamel on steel.
   g. **Ventilation:** 2 speed blower mounted above ceiling, with grille.
   h. **Lighting:** Fluorescent with solid lens diffuser.
   i. **Provide wall hooks and removable protective mats for cab walls.**
   j. **Provide stainless steel license holders for display of required certificates.**

   Design the holder to use non-visible tamper-proof fastenings. Holder shall enclose an 8 1/2” x 11” sign.

### 2.09 Car Operating Panel

1. **Provide one/two (2) (for center opening doors) flush mounted vandal resistant operating panel with an integral and front return face plate; with front return panels containing vandal resistant illuminated call buttons corresponding to floors served, in car alarm button, and DOOR OPEN DOOR CLOSE buttons.**

2. **Position alarm button at bottom of panel where it is unlikely to be accidentally actuated; not less than 35 inches above cab floor.**

3. **Include matching service cabinet integral with main front return panel, with hinged door and lock in each car containing:
a. Independent service switch.
b. Inspection switch.
c. Fan or blower switch.
d. Light switch.
e. Emergency stop switch.
f. Locate a 110 V, 15 A convenience receptacle in service cabinet.

4. Flush mounted Telephone:
   a. ADA compliant "hands free" type telephone.
   b. Acceptable manufacturer: Wurtec Inc. Cat. #11-582-VAN, or Owner approved equal.
   c. Engraved and filled lettering on panel; silk screened lettering not acceptable.

5. Additional operating switches for the special features specified.

6. Elevator identification number, 1/2 inch high, engraved and filled. Locate at top of panel.

7. Include an Integral Emergency light mounted above the main car operating panel. Include battery and charging unit within Car Operating Panel

8. Through engraved and filled car position indicator in car operating panel.

10. All screws to be tamper proof.

2.10 Car Top Inspection Station

1. Provide station device to operate each elevator from on top of the car during adjustment, inspection, maintenance, and repair.

2. Operating means shall conform to the following:
   a. Device shall be of the continuous-pressure type; operate the car at a speed not exceeding 150 ft/min; operate the car subject to the electrical protective devices required by ASME A17.1 Rule 210.1d.
   b. Device may be of the portable type provided the extension cord is permanently attached to the crosshead so that the device cannot be removed from the car top.
   c. Except as provided in ASME A17.1 Rule 210.1d(8), arrange and connect device that when operative, the movement of the car shall be solely under the control of this device, and power door operating devices shall be inoperative.
   d. Means for transferring control of the elevator to top-of-car operating device shall be:
      1. On the car top and located between the car crosshead and the side of the car nearest the hoistway entrance normally used for access to the car top;
      2. Of the manually closed type and be positively opened mechanically with their opening not be solely dependent on springs. When opened, this switch shall prevent automatic operation.
3. Device shall be used only for the purpose of adjustment, inspection, maintenance, and repair of the elevator or hoistway equipment.

4. Provide each elevator with an electric light with guard and convenience outlet fixture on the car top.

2.11 Cab Entrances

1. **Cab Doors:** Stainless steel 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction. Door shall be hung on sheave type hangers with polyurethane tires that roll on a polished track. The hanger shall be provided with adjustable eccentric rollers to take the up-thrust out of the doors. The doors shall be guided at bottom by non-metallic shoes sliding in the below listed threshold. Fabricate front return panels same as doors.

2. **Cab Door Frames:** Stainless steel; 0.058 inch (1.5mm) thick metal, standard design with non-detectable joints.

3. **Thresholds:** Nickel Silver “U” shaped saddles.

2.12 Accessibility Provisions

1. Comply with applicable code.
   a. Locate highest button in the control panel and highest operable part of the telephone a maximum of 48 inches above floor.
   b. Provide Braille numerals immediately to left of car buttons in control panel to identify each landing. Shall be glued and screwed into position.
   c. Provide handrails on rear of car.
   d. Sound audible signal in car when car is stopping at or passing landing.
   e. Provide landing lanterns with audible signal when car is arriving at landing; 1 for up stops and 2 for down stops.

2. Provide 2 inch high raised numerals and Braille on each landing jamb to identify landing number, mounted a maximum of 60 inches above floor.

2.13 Hoistway Entrances

1. **Hoistway Doors:** Stainless steel; 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction.

2. **Hoistway Door Frames:** Stainless steel; 0.058 inch (1.5 mm) thick metal, of rolled profiles, standard offset bolted design with non-detectable joints.

3. **Door and Frame Construction:** 1-1/2 hour fire rating; insulated sandwich panel door construction 1-1/4 inch (32mm) thick, minimum.

4. **Door Hangers:** Furnish and install sheave type two point suspension hangers and tracks. The sheaves shall have polyurethane tires with ball bearings properly sealed to retain grease. The hangers shall be provided with adjustable eccentric
rollers to take the up-thrust out of the doors. The tracks shall be drawn steel shapes, smooth surface and shaped to conform to the hanger sheaves.

5. **Sills:** “U” shaped saddles.

6. **Material:** Extruded aluminum, except provide nickel silver at egress floor.

7. **Interlocks:** Each hoistway entrance shall be equipped with an approved type of interlock that has been tested as required by the appropriate code. The interlock shall be designed to prevent operation of the car away from the landing until the doors are locked in the closed position, and shall prevent opening the doors at any landing from the corridor side without the use of a special tool. Interlocks shall bear Underwriters’ Laboratories “B” label of approval.

8. Hoistway door unlocking devices shall be provided on all floors and comply with ASME A17.1. These devices shall permit authorized personnel to gain access to the hoistway when the elevator car is away from the landing.

### 2.14 Landing Controls

1. **Landing Buttons:** Vandal-resistant stainless steel Illuminating type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows, including indications required by ASME A17.1. Hall button covers to be engraved and filled with pictograph detailing “In case of fire use stairs”.

2. **Hall Position Indicator:** Through engraved at egress floor.

3. **Hall lanterns:** Through engraved.

4. **Screws:** All screws to be tamper proof.

### 2.15 Finishes

1. **Structural Metal Surfaces:** Clean surfaces of rust, oil or grease; wipe clean with solvent; prime and paint.

2. **Machine Room Components:** Clean and degrease; prime one coat, finish with one coat of enamel.

3. **Galvanized Surfaces:** Clean with neutralizing solvent; prime one coat.

4. **Aluminum:** Mill finish.

5. **Wood Surfaces not Exposed to Public View:** One coat primer; one coat enamel.

6. **Stainless Steel:** #4 Satin.

### PART 3: EXECUTION

#### 3.01 Installation
1. Install in accordance with ASME A17.1, manufacturer's instructions, and applicable codes.

2. Casing:
   a. Excavate for hydraulic hole casing. There shall be a minimum 1 inch annular space between the PVC casing and the elevator hydraulic jack. PVC casing shall be sealed at the bottom with a schedule 40 PVC cap that fits the casing. The PVC casing shall be brought up to the finish floor level. Following installation of hydraulic jack in the PVC casing, fill the annular space with Union-guard 160 by Pacific Standard Chemical Co. or (Owner approved substitute). Follow Manufacture’s recommended installation procedure. The PVC casing shall be grouted into concrete floor slab with a non-shrinking concrete. There shall be a 1” galvanized nipple installed through the concrete cap into the 1” annular space between the PVC and hydraulic jack with a bleeder valve mounted on top to monitor the pressure between the PVC and jack. Wrap nipple with electrical tape.
   b. Prior to installing jack, remove water and debris from PVC casing.
   c. Double wrap hydraulic jack with an approved coating designed to protect the unit from electrolytic and chemical corrosion. Any other underground piping shall be similarly protected.
   d. Install jack assembly plumb, centered, and shimmed; use centering lugs to prevent displacement.
   e. Following installation of hydraulic jack in the PVC casing, fill the annular space with Union-guard 160 by Pacific Standard Chemical Co. or (Owner approved substitute). Follow Manufacture’s recommended installation procedure.

3. Arrange equipment in machine room so that elements requiring removal or maintenance are readily accessible without disturbing other components. Arrange for clear passage between components.

4. Install system components. Connect equipment to building utilities.

5. Mount motor and pump unit on vibration and acoustic isolators, equal to type ND by Mason Industries. Securely fasten to building supports; prevent lateral displacement.

6. Install and connect piping between machine and cylinder.

7. Install guide rails to compensate for expansion and contraction movement.

8. Accurately machine and align guide rails. Form smooth joints with machined splice plates.

9. Install hoistway door thresholds, frames, and headers in hoistway walls. Set entrances in vertical alignment with car openings and plumb hoistway lines.

10. Grout thresholds.
11. Adjust equipment for smooth and quiet operation.

12. Clean field welds; remove oxidation and residue. Apply touch up primer.

3.02 Erection Tolerances

1. Section 0#### - Quality Control: Tolerances.

2. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.2.

3. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.03 Field Quality Control

1. Section 0#### - Quality Control: Field inspection, testing, adjusting, and balancing.

2. Perform tests required by ASME A17.1 and ASME A17.2.2.

3. Test elevator in presence of Owner and Architect to ensure proper operation and compliance with specified requirements; make final adjustments as appropriate.

4. Obtain inspections and permits and make such tests as are required by governing authorities. Deliver test certificates and permits to Owner.

5. Provide two weeks written notice of date and time of tests.

6. Supply instruments and execute specific tests.

3.04 Tests By Regulatory Agencies

1. QEI Certified Testing in accordance with ASME A17.1 will be performed by Owner.

3.05 Adjusting

1. Section 0#### - Contract Closeout: Adjusting installed work.

2. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.

3. Adjust automatic floor leveling feature at each floor to achieve (+/-)1/4 inch (6mm) from floor level.

3.06 Cleaning

1. Section 0#### - Contract Closeout: Cleaning installed work.
2. Remove protective coverings from finished surfaces.
3. Clean surfaces and components ready for inspection.

3.07 Protection of Finished Work
1. Section 0### - Contract Closeout: Protecting installed work.
2. Do not permit construction traffic within cab after cleaning.

END OF STANDARD 14245
PART 1: GENERAL

1.01 Summary:

1. Section Includes:
   a. Hydraulic freight elevator system.
   b. Hydraulic cylinder.
   c. Cab with finishes and power operated car gate.
   d. Power operated hoistway doors.
   e. Motor and pump, controllers, hoistway equipment, and accessories.

2. Related Sections:
   a. Construction Facilities and Temporary Controls: Temporary power supply.
   b. Cast-in-Place Concrete: Reinforced concrete shafts.
   c. Unit Masonry System: Masonry for fire rated shafts and hoistway openings.
   d. Structural Steel: Structural hoist, divider, and sheave beams and other steel items.
   e. Metal Fabrications: Pit ladder and accessories.
   f. Plumbing Fixtures: Pit drainage.
   g. Panelboards: Electrical power to the machine room including main switch and breaker. Heat and smoke sensing devices.

3. Work Required by Other Sections:
   a. The contractor shall coordinate all work required by latest applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
   b. The machine room shall be enclosed and conditioned per the elevator manufacturer’s required tolerances and have temporary power available for installation work.
   c. Crane service shall be provided for the hoisting of the machine room equipment.
   d. All structural beams and rails shall be in place.
   e. The elevator pit shall include ladder, guarded light, GFI receptacle and sump pump with cover. Light and pump shall each be on separate dedicated circuits.

1.02 References:

1. American Architectural Manufacturers Association (AAMA):

2. American Society of Mechanical Engineers (ASME):
SECTION 14250 - HYDRAULIC FREIGHT ELEVATOR
CONSTRUCTION STANDARD

b. A17.2.2: Inspector’s Manual For Elevators.


   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
   h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   i. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, General Requirements.
   k. B209: Aluminum-Alloy Sheet and Plate.
   l. B221: Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
   m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.

5. National Electrical Manufacturer's Association (NEMA):
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.


    Or

7. Americans with Disabilities Act: Texas Accessibility Standards (TAS)

8. Other:
b. AWS D1.1: Structural Welding Code.
d. ANSI/IEEE 519: Electrical harmonic requirements.

1.03 System Description:

1. Characteristics of Elevator No. # as follows:
   1. Type: Direct plunger type hydraulic freight; cylinder in buried casing.
   2. Control: Microprocessor based static type that is software oriented.
   5. Speed: ####/ft/min (##/m/s).
   6. Loading Class: "A".
   8. Landing entrances:
      a. Size: (#'-#") wide by (#'-#") high.
      b. Type: Vertical bi-parting, power operated.
      c. Construction: Welded type.
      d. Material: Steel prime and painted.
      e. Truckable sill on lower panel.
   9. No. of Stops: Number (#) stops; Travel distance: (##'-#").
   10. No. of Openings: Number (#); (# ) at front and (#) at rear.

2. Operation (Select one):
   a. Simplex Collective.
   b. Duplex Collective.

3. Car Gate and Hoistway Door Control Features:
   a. Individual electric operators shall open and close the hoistway doors and car gate at a panel speed of not more than one foot per second without slamming. Limit switches shall be provided to stop the operator motors as the doors approach the limit of travel in opening.
   b. Provisions shall be made for the manual operation of the doors from the car in the event of a power failure.
   c. The door operators shall be arranged to open the door automatically after the car enters the automatic leveling zone at the designated landing.
   d. Each door shall use dual motors.
   e. Provide automatic closing operation which shall close the gate and door after a field adjustable period of time. Prior to automatic closing, an audible pre-closing signal shall sound to warn the operator. The audible signal shall be accomplished with a solid state toner. Bells are not acceptable.
f. Door Safety Devices: soft, mechanical safety edges, quiet in operation, with non-contact reversing light ray. Peelle or Owner approved equivalent. Gates shall be provided with passenger sequence operation.
g. Door Operators: Individual electric operators.

4. A stainless steel vandal proof hall lantern with an audible signal shall be installed at each landing entrance for each elevator. The lanterns, when illuminated, shall indicate the elevator car which shall stop at the landing and in which direction the car is set to travel.

5. Electric limit switches shall be placed in the hoistway near the terminal landings and be designed to cut off the electric current and stop the car should it run beyond either terminal landing.

6. The elevator shall be provided with a self-leveling feature that will automatically bring the car to the floor landings. This feature shall be entirely automatic and independent of the operating device and shall correct for overtravel or undertravel. The car shall be maintained level with the landing irrespective of the load.

1.04 Fireman's Service:

1. Interconnect elevator control system with building fire alarm, and smoke alarm system.

a. Provide "Firefighter's Operation" in accordance with the latest ASME A17.1.
b. Designated Landing: Egress Floor.

2. Seismic Design: In accordance with applicable code.

1.05 Emergency Operation:

1. Battery or Auxiliary Emergency Power operated emergency return device to return elevator to the Egress Floor and open car and landing doors. Auxiliary (form “C”) contacts are required to be incorporated in Shunt Trip, or fused type disconnects for emergency lowering device. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of (Form “C”) contacts which shall change state when the electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designed as the pre-transfer signal. This may not be used at the time of installation of the equipment but must be available for future use.
2. When normal power is restored, automatically return elevator to normal operation.

1.06 Submittals For Review:

Submit under provisions established in the project specifications, Division One requirements.

1. Provide a signed copy of The University of Texas ENVIRONMENTAL HEALTH AND SAFETY CONSTRUCTION SITE PROCEDURES FOR CONTRACTORS, prior to commencement of any work.

2. Shop Drawings: Include following information:
   a. Motor, hydraulic pumps, valves, controller, selector, governor, and other component locations.
   b. Car, machine beams, guide rails, buffers, and other components in hoistway.
   c. Rail bracket spacing and maximum loads imposed on guide rails requiring transfer to structure.
   d. Individual weight of principle components and load reactions at points of support.
   e. Loads on hoisting beams.
   f. Clearances and over travel.
   g. Locations of components in machine room. Show arrangement so that moving elements and other equipment can be removed for repairs without disturbing other components. Arrange equipment for clear passage through doors and access doors.
   h. Location in hoistway and machine room of connections for car light and telephone.
   i. Locations of access doors, doors, and frames.
   j. Expected heat dissipation of elevator equipment in machine room.
   k. Electrical characteristics and connection requirements.

3. Samples: Illustrate cab interior finishes and car and hoistway door and frame finishes.

1.07 Submittals At Project Close-Out:


2. Furnish two copies of bound maintenance manuals for each elevator. Include full maintenance and operating instructions, parts list, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams.
3. Include legible schematic of hydraulic piping and wiring diagrams of installed electrical equipment and changes made in the work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

4. Provide two copies of master electric and hydraulic schematics and one copy of lubrication chart.

5. Tools, electrical prints, parts catalogs, keys, door keys, protective cab pads and other proprietary components shall be turned over to The University of Texas Utilities Service Elevator Inspection Department, upon final inspection of the elevator.

1.08 Quality Assurance:

1. Perform Work in accordance with the latest ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section.

2. Fabricate and install door and frame assemblies in accordance with NFPA 80 and UL 10B.

3. Qualifications:

   a. **Contractor:**

      1. Maintain a warehouse and maintenance service in the City of Austin, Texas.
      2. Minimum (5) years, prior to bid date of this project, in the business of providing elevator service and having warehouse facilities.
      3. Maintain in Austin, Texas an adequate stock of parts for emergency and replacement purposes.
      4. Qualified personnel available at Austin, Texas to insure fulfillment of maintenance and/or repair service on a 24 hour emergency call basis.

   a. **Installer:** Employees and supervisor on payroll of elevator equipment manufacturer.

   b. **Equipment:** Manufactured and guaranteed by the selling company; manufactured in its entirety (exclusive of cabs and doors) by the designer and manufacturer.

   c. **Parts, accessories, and appurtenances:** Erected, installed, adjusted, tested and placed in operation by competent mechanics skilled in this work and under the direct control and supervision of the installers experienced foreman.

1.09 Regulatory Requirements:

1. Conform to the latest ASME A17.1 code for manufacture and installation of elevator system.

2. Conform to State of Texas Accessibility Standards for provisions for the disabled.
3. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

1.10 Warranty:

2. Correct defective Work within a one year period after Date of Substantial Completion.
3. Warranty: Include coverage for elevator operating equipment and devices.
4. Sealed jack assembly: 20 year unconditional warranty. Jack packing is excluded from this warranty.

1.11 Maintenance Service:

2. Provide service and maintenance of elevator system and components for Ninety (90) Days from Date of Final Acceptance of last elevator.
3. Examine system components monthly. Clean, adjust, and lubricate equipment.
4. Include systematic examination, adjustment, and lubrication of elevator equipment; maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.
   a. Include monthly fire service, battery lowing and emergency lighting inspections and test.
   b. Include elevator cab handrails.
5. Perform work without removing cars during peak traffic periods.
6. Maintain in Austin, Texas an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24 hour emergency call basis for this maintenance period.
7. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer.
8. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

1.12 Extra Materials:

2. Supply three extra keys for each keyed switch.

3. Supply hand held computer and other proprietary components necessary to test and maintain elevator and equipment. Include updates or modifications of test equipment for 10 years.

4. Tools, electrical prints, parts catalogs, keys, door keys, protective cab pads and other proprietary components shall be turned over to The University of Texas Utilities Service Elevator Inspection Department, upon final inspection of the elevator.

PART 2: PRODUCTS

2.01 Manufacturers:

1. Contract Documents are based on Approved products.

2. Equivalent products by the following are acceptable:

   a. Motion Control Engineering
   b. Thyssen/Dover
   c. KONE Inc.
   d. Tejas Elevator
   e. United Technologies Otis Elevator Company
   f. Schindler Elevator Corp
   g. Elevator Products Corp
   h. Innovation Industries Corp. Hollister Whitney Elevator Corp.
   i. PTL Car & Hall Fixtures
   j. Owner approved equal

3. Substitutions: Under provisions established in the project specifications, Division Two requirements.

2.02 Materials:

1. Steel:

   b. Sheet: ASTM A 446, galvanized, stretcher leveled, Commercial Grade.

2. Stainless Steel: ASTM A 167, Type 302 or 304.

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a. Extrusions: ASTM B 221.

4. Plywood: APA Structural I, Grade C-D, sanded.

5. Paints:
   a. Primer for steel: Red Oxide.
   b. Primer for wood: Alkyd primer/sealer.
   c. Enamel: Semigloss alkyd.

2.03 Components:

1. Motors, Pumps, Valves, Regulators, Fluid Tank, Hydraulic Fluid, Controller, Controls, Buttons, Wiring, Devices, and Indicators: As required by NFPA 70.

2. Power Unit (Oil Pumping and Control Mechanism):
   a. Pump and valves: Specifically designed for elevator application; the pump shall be of the positive displacement type. Pump/valve assembly shall be suspended within the oil reservoir by a rubber isolated suspension system to allow easy removal of components without draining oil from the reservoir. Silencer shall be installed integrally in the oil reservoir interior. The design shall be such that the silencer shall contain no degradable parts. Where pump/valve assembly requires location outside of reservoir, drip pan under entire unit shall be provided.
   b. Oil Control Valve: Shall contain in a single housing; high pressure relief valve; check valve; automatic unloading up start valve; lowering and leveling valve and magnetic control. Welded manifolds with separate valves to accomplish each function will not be permitted.
   c. Motor: Designed for oil-hydraulic elevator service, of standard manufacture, and of duty rating to comply with specified speed and load. Motor rating for the number of starts per hour shall be suitable for the expected use of the elevator (minimum 80 starts per hour).
   d. Relief valve: Externally adjustable and capable of bypassing the total oil flow before the pressure exceeds 150 percent of the working pressure and that the system will withstand this pressure. The relief valve to be pre-set to open at a pressure not greater than 125 percent of working pressure. The size of the relief valve and by-pass shall be sufficient to pass the maximum rated capacity of the pump without raising the pressure more than 20 percent above that at which the valve opens.
   e. Up Start and Stop Valve: Externally adjustable and designed to bypass oil flow during start and stop of motor pump assembly. Valve shall close
slowly, gradually diverting oil to or from the jack unit, insuring smooth up
starts and up stops.

f. **Oil Viscosity Control:** When the oil temperature drops below the optimum
operating temperature means shall be provided to maintain the proper
viscosity of the oil.

designed, sized according to ASME A17.1 Code with safety factors.

4. **Jack Unit:**

   a. Designed and constructed in accordance with the applicable requirements of
the ASME A17.1 Code; Sized to lift the gross load to height specified;
Factory tested to insure adequate strength and freedom from leakage; No
brittle material, such as gray cast iron, shall be used in the jack construction.

   b. Components:

   1. **Plunger:** Heavy seamless steel tubing accurately turned and polished.
   2. **Stop ring:** Electrically welded to plunger to positively prevent plunger
leaving the casing.
   3. Internal guide bearing, packing or seal of suitable design and quality.
   4. Drip ring around cylinder top.
   5. Cylinder constructed of steel pipe and provided with a pipe connection
and air bleeder.
   6. **Brackets:** Welded to the jack cylinder for supporting elevator on pit
channels.
   7. **Accessories:** As required.

   c. Provide required cylinder hole for hydraulic jack complete with an outer
steel casing per ASME A17.1 and an inter watertight schedule 40 PVC
casing.

5. **Operational Controller:**

   a. Motion Control Engineering Inc. (MCE) Only. Controller shall be NEMA 1
b. **Drive Control:** PHC

6. **Landing System:** Shall be compatible with MCE controller.

   a. (LS-QUTE)

2.04 **Electrical System Characteristics:**

1. **Electrical Characteristics:**
a. 480 volts, three phase, 60 Hz.  
b. Refer to Division 16, - Equipment Wiring Systems: Electrical connections.

2. **Motor:** NEMA code letter G or as required for torque and duty requirements.  
   \((\#\#)\) hp motor \(\#(\#\#)\) rated load amperes. Class F insulation rating.

3. **Starter Characteristics:**
2.05 Electrical Components:

1. Boxes, Conduit, Wiring, and Devices: Required by NFPA 70 and Division 16.

2. Fittings: Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. Spare Conductors: Include 10 percent extra conductors and two pairs of shielded audio cables in traveling cables. Do not parallel conductors to increase electric current capacity unless individually fused.

4. Do not use armored flexible metal conduit as a grounding conductor.

5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine rooms. Provide additional components and wiring to suit machine room layout.

6. All labeling required by ASME A.17.1 shall be of permanently engraved/embossed and permanently affixed plaques. Plaques may be either plastic laminate or metallic. “Permanent Marker” or “Labeling Tape” ID’s shall not be used.

2.06 Lubrication:

1. Grease Fittings: For lubricating bearings requiring periodic lubrication.

2. Lubrication Points: Visible and easily accessible.

2.07 Car Structural Fabrication:

1. Frame: Fabricated steel frame of formed or structural steel shapes, gusseted and rigidly welded.

2. Platform: Aluminum checkered plate, 1/4” thick laid over steel stringers and subflooring. The car sling shall be completely isolated from piston by vibration absorbing materials.

3. Sling: Shall consist of heavy steel stiles, properly affixed to a steel crosshead and safety channels with adequate bracing members to remove all strain from the car enclosure.

4. Car Guides: Rubber faced, spring loaded roller guides of suitable size for a smooth quiet operation.

2.08 Cab Fabrication:
1. **Cab Design:**
   
a. **Cab Size:** Platform (\(\#' - \#''\))X(\(\#' - \#''\)) Floor to ceiling (\(\#' - \#''\)).
   b. **Flooring:** Aluminum checkered plate, 1/4" thick.
   c. **Car Gate:** Single Blade, expanded metal, power operated.
   d. **Sides and rear:** Rigidized stainless steel panels with diamond pattern.
   e. **Ceiling:** Baked enamel on 14 gauge steel. \(\text{____ ft.____ in. under ceiling.}\)
   f. **Ventilation:** 2 speed blower mounted above ceiling, with grille.
   g. **Lighting:** Fluorescent with solid lens diffuser.
   h. **Controls and fixtures:**
      
      1. Operating panel flush mounted vandal resistant in side wall.
      2. Flush mounted telephone.
      3. Car position indicator.

   i. **License Holders:** Provide stainless steel license holders for display of required certificates. Design the holder to use non-visible tamper-proof fastenings. Holder shall enclose an 8 1/2” x 11” sign.

2.09 **Car Operating Panel:**

1. **Provide one flush mounted vandal resistant operating panel with an integral and front return face plate; with front return panels containing vandal resistant illuminated car buttons corresponding to floors served, in car alarm button, and DOOR OPEN, DOOR CLOSE buttons.**
   
   a. Locate a 110 V, 15 Amp GFI convenience receptacle in car panel.
   b. Elevator identification number, 1/2 inch high, engraved and filled. Locate at top of panel.
   c. Engraved and filled lettering on panel; silk screened lettering not acceptable.

2. **Position alarm button and emergency stop switch not less than 35 inches above cab floor where it is unlikely to be accidentally actuated. Key switches to be mounted in car panel. Emergency stop, push-pull or toggle type shall activate alarm or bell when operated.**

3. **Switches mounted in car operating panel:**
   
   a. Independent service switch (key operated).
   b. Fan or blower switch (key operated).
   c. Light switch (key operated).
4. Emergency light: Include an Integral Emergency light mounted above the main Car operating panel. Include battery and charging unit within Car Operating Panel.

5. ADA Flush mounted telephone: Wurtec Inc. Cat. #11-582-van, or Owner approved equal.

6. Car Position Indicator: Through engraved and filled car position indicator in car operating panel.

7. Additional operating switches for the special features specified:
   a. DOOR HOLD OPEN PUSH BUTTON to be included. When activated by momentary pressure, the doors shall remain open for an adjustable period of time (1-180 seconds). This extended door open time will be canceled by activation of the DOOR CLOSE button. This circuit shall be rendered inoperative during Fire Service.

2.10 Car Top Inspection Station:
   1. Provide station device to operate each elevator from on top of the car during adjustment, inspection, maintenance, and repair.
   2. Operating means shall conform to the following:
      a. Device shall be of the continuous-pressure type; operate the car at a speed not exceeding 150 ft/minute; operate the car subject to the electrical protective devices required by ASME A17.1 Rule 210.1d.
   3. Device shall be used only for the purpose of adjustment, inspection, maintenance, and repair of the elevator or hoistway equipment.
   4. Provide each elevator with an electric light with guard and GFI convenience outlet fixture on the car top.

2.11 Cab Entrances:
   1. Car Gate: Single Blade expanded metal, power operated, 6’-0” height. With standard returns.
   2. Gates shall be provided with soft mechanical safety edge and a non-contact reversing device, Peelle or equivalent, and with passenger sequence operation.

2.12 Accessibility Provisions:
   1. Comply with applicable code.
a. Provide 2 inch high raised Braille and numerals on each landing jamb to identify landing number, characters shall be centered 60 inches above finish floor.

b. Provide Braille numerals immediately to left of car buttons, DOOR OPEN DOOR CLOSE, and alarm buttons in the control panel to identify each landing. Shall be glued and screwed into position.

2.13 Hoistway Entrances:

1. Hoistway Doors shall be Peel doors (or Owner approved equal): Prime painted steel vertical BI-parting; 0.058 inch ([1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction, 4”x12” tempered glass vision panel.

2. Hoistway Door Frames: Steel channel established in the project specifications, Division Two requirements.

a. Provide 2 inch high raised numerals and Braille on each landing jamb to identify landing number, characters shall be centered 60 inches above finish floor.

3. Door Construction: 1-1/2 hour fire rating; insulated sandwich panel door construction 1-1/4 inch (32mm) thick, minimum; Truckable sill on lower door panel.

4. Sills: Steel edge angle established in the project specifications, Division Two requirements.

2.14 Landing Controls:

1. Landing Buttons: Vandal-resistant stainless steel Illuminating type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows, including indications required by ASME A17.1. Hall button covers to be engraved and filled with pictograph detailing “In case of fire use stairs”. Accepted alternate “Cast Appendix H” inset to face plate as manufactured by Stencil Cutting & Supply Company.

2. DOOR OPEN DOOR CLOSE buttons. Vandal-resistant type. Constant pressure on the CLOSE button shall close the door. Momentary pressure on the OPEN button shall re-open the door, provided the car is at a landing.

3. Screws: All screws to be pin in hex tamper proof.

2.15 Finishes:
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1. **Structural Metal Surfaces:** Clean surfaces of rust, oil or grease; wipe clean with solvent; prime and paint.

2. **Machine Room Components:** Clean and degrease; prime one coat, finish with one coat of enamel.

3. **Galvanized Surfaces:** Clean with neutralizing solvent; prime one coat.

4. **Aluminum:** Mill finish.

5. **Wood Surfaces not Exposed to Public View:** One coat primer; one coat enamel.

6. **Stainless Steel:** #4 Satin.

**PART 3: EXECUTION**

3.01 **Installation:**

1. Install in accordance with ASME A17.1, manufacturer's instructions, and applicable codes.

2. **Casing:**
   
a. Excavate for hydraulic hole casing. Set steel casing in hole free of rocks and other protrusions. Backfill open space between the hole and steel casing with settling sand. The PVC casing shall be of suitable size to allow a minimum annular space of 1-1/2 inches between the PVC and steel casing. After plumbing the PVC fill the 1-1/2 inch annular space between the steel casing and PVC casing with settling sand. There shall be a minimum 1-1/2 inch annular space between the PVC casing and the elevator hydraulic jack. PVC casing shall be sealed at the bottom with a schedule 40 PVC cap that fits the casing. The PVC casing shall be brought up to the finish floor level. Following installation of hydraulic jack in the PVC casing, fill the annular space with Union-guard 160 by Pacific Standard Chemical Co. or (Owner approved substitute). Follow Manufacture’s recommended installation procedure. The PVC casing shall be grouted into concrete floor slab with a non-shrinking concrete. There shall be a 1” galvanized nipple installed through the concrete cap into the 1-1/2” annular space between the PVC and hydraulic jack with a bleeder valve mounted on top to monitor the pressure between the PVC and jack. Wrap nipple with electrical tape.

   b. Prior to installing jack, remove water and debris from PVC casing.

   c. Double wrap hydraulic jack with an approved coating designed to protect the unit from electrolytic and chemical corrosion. Any other underground piping shall be similarly protected.
d. Install jack assembly plumb, centered, and shimmed; use centering lugs to prevent displacement.

e. Following installation of hydraulic jack in the PVC casing, fill the annular space with Union-guard 160 by Pacific Standard Chemical Co. Follow Manufactures recommended installation.

3. Arrange equipment in machine room so that elements requiring removal or maintenance are readily accessible without disturbing other components. Arrange for clear passage between components.

4. Install system components. Connect equipment to building utilities.

5. Mount motor and pump unit on vibration and acoustic isolators, equal to type ND by Mason Industries. Securely fasten to building supports; prevent lateral displacement.

6. Install and connect piping between machine and cylinder.

7. Install guide rails to compensate for expansion and contraction movement.

8. Accurately machine and align guide rails. Form smooth joints with machined splice plates.

9. Install hoistway doors. Set doors in vertical bi-parting alignment with car openings and plumb hoistway lines.

10. Adjust equipment for smooth and quiet operation.

11. Clean field welds; remove oxidation and residue. Apply touch up primer and paint.

3.02 Erection Tolerances:

1. Quality Control: Tolerances.

2. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.2.

3. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.03 Field Quality Control:

1. Quality Control: Field inspection, testing, adjusting, and balancing.

2. Perform tests required by ASME A17.1 and ASME A17.2.2.

3. Test elevator in presence of Owner and Architect to ensure proper operation and compliance with specified requirements; make final adjustments as appropriate.
4. Obtain inspections and permits and make such tests as are required by governing authorities. Deliver test certificates and permits to Owner.

5. Provide two weeks written notice of date and time of tests.

6. Supply instruments and execute specific tests.

3.04 Tests By Regulatory Agencies:

1. QEI Certified Testing in accordance with ASME A 17.1 will be performed by Owner.

3.05 Adjusting:


2. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.

3. Adjust automatic floor leveling feature at each floor to achieve (+/-)1/4 inch (6mm) from flush.

3.06 Cleaning:


2. Remove protective coverings from finished surfaces.

3. Clean surfaces and components ready for inspection.

3.07 Protection Of Finished Work:


2. Do not permit construction traffic within cab after cleaning.

END OF STANDARD 14250
1.01 Summary

1. Section Includes:
   a. Hydraulic service elevator system.
   b. Hydraulic cylinder.
   c. Cab with doors, frames, and finishes.
   d. Hoistway doors and frames.
   e. Motor and pump, controllers, hoistway, equipment, and accessories.

2. Related Sections:
   a. Construction Facilities and Temporary Controls: Temporary power supply.
   b. Cast-in-Place Concrete: Reinforced concrete shafts.
   c. Unit Masonry System: Masonry for fire rated shafts and hoistway openings.
   d. Structural Steel: Structural hoist, divider, and sheave beams and other steel items.
   e. Metal Fabrications: Pit ladder and accessories.
   f. Plumbing Fixtures: Pit drainage.
   g. Panelboards: Electrical power to the machine room including main switch and breaker. Heat and smoke sensing devices.

3. Work Required by Other Sections:
   a. The contractor shall coordinate all work required by the latest applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
   b. The machine room shall be enclosed and conditioned per the elevator manufacturer’s required tolerances and have temporary power available for installation work.
   c. Crane service shall be provided for the hoisting of the machine room equipment.
   d. All structural beams and rails shall be in place.
   e. The elevator pit shall include ladder, guarded light, GFI receptacle and sump pump with cover. Light and pump shall each be on separate dedicated circuits.

1.02 References

1. American Architectural Manufacturers Association (AAMA):

2. American Society of Mechanical Engineers (ASME):
b. A17.2.2: Inspector’s Manual For Elevators.


4. **American Society for Testing and Materials (ASTM):**
   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
   h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   i. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, General Requirements.
   k. B209: Aluminum-Alloy Sheet and Plate.
   l. B221: Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
   m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.

5. **National Electrical Manufacturer's Association (NEMA):**
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.

6. **National Fire Protection Association (NFPA):**

7. **Texas Department of Licensing and Regulation (TDLR):**
   a. Texas Accessibility Standards (TAS).

8. **Other:**
1.03 System Description

1. Characteristics of Elevator No. # as follows:
   a. Type: Hydraulic; cylinder in buried casing.
   b. Control: Microprocessor based static type that is software oriented.
   d. Rated Net Capacity: #### lbs. (####kg).
   e. Rated Speed: ### ft/min (###m/s).
   g. Cab Height: (#'-#").
   h. Cab Clear Ht. to suspended ceiling: (#'-#").
   i. Hoistway and Cab Entrance Frame opening size: (#'-#")x(#'-#").
   j. Door Type/Operation: Select one: Center opening, single slide; center opening, two speeds; single slide; single slide, two speeds.
   k. No. of Stops: Number (#) stops; Travel distance: (#'-#").
   l. No. of Openings: Number (#); (#) at front and (#) at rear.

2. Operation (Select one):
   a. Simplex Collective.
   b. Duplex Collective.
   c. Group microprocessor controlled demand allocation.

3. Programmable controls shall allow: When car without registered car calls arrives at floor where both up and down calls are registered, initially respond to hall call in direction of travel. If no car or hall call is registered for future travel in that direction, respond to hall call in opposite direction.

4. A stainless steel vandal proof hall lantern with an audible signal shall be installed at each landing entrance for each elevator. The lanterns, when illuminated, shall indicate the elevator car, which shall stop at the landing and in which direction the car, is set to travel.

5. Door Operation and Control Features:
   a. Furnish a direct current motor driven heavy-duty operator. Operator shall be compatible with MCE Controller and adjustable without the use of proprietary tools. The system shall be designed to operate the car and
hoistway doors simultaneously. Door movements shall be electrically cushioned at both limits of travel and the door operating mechanism shall be arranged for manual operation in the event of a power failure. A door protection system using microprocessor controlled infrared light beams (Janis or Microscan or equal) shall be provided. The beams shall project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen. A mechanical reopening device shall not be provided. Doors shall automatically open when the car arrives at the landing and shall automatically close after an adjustable time interval or when car is dispatched to another landing. Direct drive geared operators, A.C. controlled units with oil checks, or other deviations of these are not acceptable.

b. If the electronic detector is activated when the doors are closing and the doors are more than one-third closed, they shall reverse direction and open only partially. The doors shall begin to reclose when the electronic detector is deactivated. The doors shall reopen fully if the electronic detector is activated longer than a fixed time.

c. Nudging:
The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If the door movement is obstructed longer than a field programmable time value, a buzzer shall sound and the doors shall close at a reduce speed.

d. The current door hold time shall be changed to a shorter field programmable time when the door protection system is activated.

e. The microprocessor control system shall provide separate timers for car call door hold open time and hall car door hold open time. The door hold open times shall be field programmable.

6. Electric limit switches shall be placed in the hoistway near the terminal landings and be designed to cut off the electric current and stop the car should it run beyond either terminal landing.

7. The elevator shall be provided with a self-leveling feature that will automatically bring the car to the floor landings. This feature shall be entirely automatic and independent of the operating device and shall correct for overtravel or undertravel. The car shall be maintained level with the landing irrespective of the load.

1.04 Fireman's Service

1. Provide "Firefighter's Operation" in accordance with the latest ASME A17.1.
a. Interconnect elevator control system with building fire alarm, and smoke alarm system.
b. Designated Landing: Egress Floor.

2. Seismic Design: In accordance with applicable code.

1.05 Independent Service

1. Provide "Independent Service switch" in service cabinet in car. toggle switch activation will remove that car from normal operation and cancel all pre-registered car calls and hall calls for that car.

2. Car will respond to selected floor. Car will not respond to any calls from hall call buttons. Car will only respond to calls placed on the car-operating panel. Doors will remain open at last landing requested. Doors will close with a constant pressure on "DOOR CLOSE" button.

3. Toggle switch activation to normal operation will return car to normal operation.

1.06 Emergency Operation

1. Battery or Auxiliary Emergency Power operated emergency return device to return elevator to the Egress Floor and open car and landing doors. Auxiliary (form “C”) contacts are required to be incorporated in Shunt Trip, or fused type disconnects for emergency lowering device. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of (Form “C”) contacts, which shall change state when the electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts, which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designed as the pre-transfer signal. This may not be used at the time of installation of the equipment but must be available for future use.

2. When normal power is restored, automatically return elevator to normal operation.

1.07 Submittals For Review
Submit under provisions established in the project specifications, Division One requirements.
1. Provide a signed copy of The University of Texas ENVIRONMENTAL HEALTH AND SAFETY CONSTRUCTION SITE PROCEDURES FOR CONTRACTORS, prior to commencement of any work.

2. **Shop Drawings:** Include following information:
   a. Motor, hydraulic pumps, valves, controller, selector, governor, and other component locations.
   b. Car, machine beams, guide rails, buffers, and other components in hoistway.
   c. Rail bracket spacing and maximum loads imposed on guide rails requiring transfer to structure.
   d. Individual weight of principle components and load reactions at points of support.
   e. Loads on hoisting beams.
   f. Clearances and over travel.
   g. Locations of components in machine room. Show arrangement so that moving elements and other equipment can be removed for repairs without disturbing other components. Arrange equipment for clear passage through doors and access doors.
   h. Location in hoistway and machine room of connections for car light and telephone.
   i. Locations of access doors, doors, and frames.
   j. Expected heat dissipation of elevator equipment in machine room.
   k. Electrical characteristics and connection requirements.

3. **Samples:** Illustrate cab interior finishes and car and hoistway door and frame finishes.

1.08 **Submittals At Project Closeout**

1. **Contract Closeout:** Procedures for submittals.

2. Furnish two copies of bound maintenance manuals for each elevator. Include full maintenance and operating instructions, parts list, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams.

3. Include legible schematic of hydraulic piping and wiring diagrams of installed electrical equipment and changes made in the work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

4. Provide two copies of master electric and hydraulic schematics and one copy of lubrication chart.

5. Tools, electrical prints, parts catalogs, keys, door keys, protective cab pads and other proprietary components shall be turned over to The University of Texas...
Utilities Service Elevator Inspection Department, upon final inspection of the elevator.

1.09 Quality Assurance

1. Perform Work in accordance with the latest ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section.

2. Fabricate and install door and frame assemblies in accordance with NFPA 80 and UL 10B.

3. Qualifications:
   a. **Contractor:**
      1. Maintain a warehouse and maintenance service in the City of Austin, Texas.
      2. Minimum (5) years, prior to bid date of this project, in the business of providing elevator service and having warehouse facilities.
      3. Maintain in Austin, Texas an adequate stock of parts for emergency and replacement purposes.
      4. Qualified personnel available at Austin, Texas to insure fulfillment of maintenance and/or repair service on a 24-hour emergency call basis.
   a. **Installer:** Employees and supervisor on payroll of elevator equipment manufacturer.
   b. **Equipment:** Manufactured and guaranteed by the selling company; manufactured in its entirety (exclusive of cabs and doors) by the designer and manufacturer.
   c. **Parts, accessories, and appurtenances:** Erected, installed, adjusted, tested and placed in operation by competent mechanics skilled in this work and under the direct control and supervision of the Installers experienced foreman.

1.10 Regulatory Requirements

1. Conform to the latest ASME A17.1 code for manufacture and installation of elevator system.

2. Conform to State of Texas Accessibility Standards for provisions for the disabled.

3. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

1.11 Warranty

2. Correct defective Work within a one-year period after Date of Substantial Completion.

3. Warranty: Include coverage for elevator operating equipment and devices.

4. Sealed jack assembly: 20 year unconditional warranty. Jack packing is excluded from this warranty.

11.2 Maintenance Service


2. Provide service and maintenance of elevator system and components for Ninety-Days (90) from Date of Final Acceptance of last elevator.

3. Examine system components monthly. Clean, adjust, and lubricate equipment.

4. Include systematic examination, adjustment, and lubrication of elevator equipment; maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.
   a. Include monthly Fire Service, battery lowing and emergency light inspections and test.
   b. Include Hoistway sills and Car sills.
   c. Include elevator cab handrails.

5. Perform work without removing cars during peak traffic periods.

6. Maintain in Austin, Texas an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24-hour emergency call basis for this maintenance period.

7. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer.

8. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

11.3 Extra Materials


2. Supply three extra keys for each keyed switch.

3. Supply hand held computer and other proprietary components necessary to test and maintain elevator and equipment. Include updates or modifications of test equipment for 10 years.
PART 2  PRODUCTS

2.01 Manufacturers

1. Contract Documents are based on approved products.
2. Equivalent products by the following are acceptable:
   a. Motion Control Engineering
   b. Thyssen/Dover
   c. KONE Inc.
   d. Tejas Elevator
   e. United Technologies Otis Elevator Company
   f. Schindler Elevator Corp
   g. Elevator Products Corp
   h. Innovation Industries Corp
   i. Hollister Whitney Elevator Corp.
   j. PTL Car & Hall Fixtures
   k. Owner approved equal

3. Substitutions: Under provisions established in the project specifications, Division Two requirements.

2.02 Materials

1. Steel:
   b. Sheet: ASTM A 446, galvanized, stretcher leveled, Commercial Grade.

2. Stainless Steel: ASTM A 167, Type 302 or 304.

   a. Extrusions: ASTM B 221.

4. Plywood: APA Structural I, Grade C-D, sanded.

5. Plastic Laminate: NEMA LD-3, General Purpose Type.

6. Paints:
   a. Primer for steel: Red Oxide.
   b. Primer for wood: Alkyd primer/sealer.
   c. Enamel: Semigloss alkyd.

2.03 Components

1. Motors, Pumps, Valves, Regulators, Fluid Tank, Hydraulic Fluid, Controller, Controls, Buttons, Wiring, Devices, and Indicators: As required by NFPA 70.
2. Power Unit (Oil Pumping and Control Mechanism):
   a. **Pump and valves**: Specifically designed for elevator application; the pump shall be of the positive displacement type. Pump/valve assembly shall be suspended within the oil reservoir by a rubber isolated suspension system to allow easy removal of components without draining oil from the reservoir. A silencer shall be installed integrally in the oil reservoir interior. The design shall be such that the silencer shall contain no degradable parts. Where pump/valve assembly requires location outside of reservoir, drip pan under entire unit shall be provided.
   b. **Oil Control Valve**: shall contain in a single housing; high pressure relief valve; check valve; automatic unloading up start valve; lowering and leveling valve and magnetic control. Welded manifolds with separate valves to accomplish each function will not be permitted.
   c. **Motor**: Designed for oil-hydraulic elevator service, of standard manufacture, and of duty rating to comply with specified speed and load. Motor rating for the number of starts per hour shall be suitable for the expected use of the elevator (minimum 80 starts per hour).
   d. **Relief valve**: Externally adjustable and capable of bypassing the total oil flow before the pressure exceeds 150 percent of the working pressure and that the system will withstand this pressure. The relief valve to be pre-set to open at a pressure not greater than 125 percent of working pressure. The size of the relief valve and by-pass shall be sufficient to pass the maximum rated capacity of the pump without raising the pressure more than 20 percent above that at which the valve opens.
   e. **Up Start and Stop Valve**: Externally adjustable and designed to bypass oil flow during start and stop of motor pump assembly. Valve shall close slowly, gradually diverting oil to or from the jack unit, insuring smooth up starts and up stops.
   f. **Oil Viscosity Control**: When the oil temperature drops below the optimum operating temperature means shall be provided to maintain the proper viscosity of the oil.


4. Jack Unit:
   a. Designed and constructed in accordance with the applicable requirements of the ASME A17.1 Code; Sized to lift the gross load to height specified; Factory tested to insure adequate strength and freedom from leakage; No brittle material, such as gray cast iron, shall be used in the jack construction.
   b. Components:
      1. Plunger Heavy seamless steel tubing accurately turned and polished.
      2. Stop ring: Electrically welded to plunger to positively prevent plunger leaving the casing.
      3. Accessories:
      4. Internal guide bearing, packing or seal of suitable design and quality.
      5. Drip ring around cylinder top.
6. Cylinder constructed of steel pipe and provided with a pipe connection and air bleeder.
7. Brackets: Welded to the jack cylinder for supporting elevator on pit channels.
   c. Provide required cylinder hole for hydraulic jack complete with an outer steel casing per ASME A17.1 and an inner watertight schedule 40 PVC casing.

5. **Operational Controller:**
   a. Motion Control Engineering Inc. **(MCE) Only.** Controller shall be NEMA 1
   b. Drive Control: PHC

6. **Landing System:** Shall be compatible with MCE controller.
   a. (LS-QUTE)

2.04 Electrical System Characteristics

1. **Electrical Characteristics:**
   a. 480 volts, three phase, 60 Hz.
   b. Refer to Division 16, - Equipment Wiring Systems: Electrical connections.

2. **Motor:** NEMA code letter G or as required for torque and duty requirements. (##) hp motor @ (###) rated load amperes. Class F insulation rating.

3. **Starter Characteristics:**

2.05 Electrical Components

1. **Boxes, Conduit, Wiring, and Devices:** Required by NFPA 70 and under provisions of Division 16.

2. **Fittings:** Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. **Spare Conductors:** Include 10 percent extra conductors and two pairs of shielded audio cables in traveling cables. Do not parallel conductors to increase electric current capacity unless individually fused.

4. Do not use armored flexible metal conduit as a grounding conductor.
5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine rooms. Provide additional components and wiring to suit machine room layout.

6. All labeling required by ASME A.17.1 shall be of permanently engraved/embossed and permanently affixed plaques. Plaques may be either plastic laminate or metallic. “Permanent Marker” or “Labeling Tape” ID’s shall not be used.

2.06 Lubrication

1. **Grease Fittings:** For lubricating bearings requiring periodic lubrication.

2. **Lubrication Points:** Visible and easily accessible.

2.07 Car Structural Fabrication

1. **Frame:** Fabricated steel frame of formed or structural steel shapes, gusseted and rigidly welded.

2. **Platform:**
   a. Fire retardant treated plywood subflooring assembly laid over steel stringers and ready to receive floor finish. The car sling shall be completely isolated from piston by vibration absorbing materials.
   b. **Platform:** Aluminum checkered plate, 1/4” thick laid over steel stringers and subflooring. The car sling shall be completely isolated from piston by vibration absorbing materials.

3. **Sling:** Shall consist of heavy steel stiles, properly affixed to a steel crosshead and safety channels with adequate bracing members to remove all strain from the car enclosure.

4. **Car Guides:** Rubber faced, spring loaded roller guides of suitable size for a smooth quiet operation.

2.08 Cab Fabrication

1. Based on (List Model #) Laminated Panel Cab manufactured by (List Company).

2. **Cab Design:** Passenger Elevator:
   a. **Flooring:** (Rubber flooring as specified in section 0 ####) (Aluminum checkered plate, 1/4” thick).
   b. **Sides and rear walls:** Plastic laminate.
   c. **Handrails:** Stainless steel, cylindrical profile.
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d. Front and rear returns and transom: Stainless steel with No. 4 finish.
e. Ceiling: Translucent suspended.  ____ ft. ____ in. under ceiling.
f. Canopy: Baked enamel on steel. ____ ft. ____ in. under canopy.
g. Ventilation: 2 speed blower mounted above ceiling, with grille.
h. Lighting: Fluorescent with solid lens diffuser.
i. Provide wall hooks and removable protective mats for cab walls.
j. Provide stainless steel license holders for display of required certificates. Design the holder to use non-visible tamper-proof fastenings. Holder shall enclose an 8 1/2” x 11” sign.

2.09 Car Operating Panel

1. Provide one/two (2) (for center opening doors) flush mounted vandal resistant operating panel with an integral and front return face plate; with front return panels containing vandal resistant illuminated car buttons corresponding to floors served, in car alarm button, and DOOR OPEN, DOOR CLOSE buttons.

2. Position alarm button at bottom of panel where it is unlikely to be accidentally actuated; not less than 35 inches above cab floor.

3. Include matching service cabinet integral with main front return panel, with hinged door and lock in each car containing:

   a. Independent service switch. (Toggle switch)
   b. Inspection switch. (Toggle switch)
   c. Fan or blower switch. (Toggle switch)
   d. Light switch. (Toggle switch)
   e. Emergency stop switch. (Toggle switch or push pull)
   f. Locate a 110 V, 15 Amp GFI convenience receptacle in service cabinet.

4. Flush mounted Telephone:
   a. ADA compliant "hands free" type telephone.
   b. Acceptable manufacturer: Wurtec Inc. Cat. #11-582-VAN, or Owner approved equal.
   c. Engraved lettering on panel; silk screened lettering not acceptable.

5. Additional operating switches for the special features specified.

6. Elevator identification number, 1/2 inch high, engraved and filled. Locate at top of panel.

7. Include an emergency light mounted above the car-operating panel.

8. Through engraved and filled car position indicator in car operating panel or above car doors.
9. All screws to be tamper proof.

10. DOOR HOLD OPEN PUSH BUTTON to be included. When activated by momentary pressure, the doors shall remain open for an adjustable period of time (1-180 seconds). This extended door open time will be canceled by activation of the DOOR CLOSE button. This circuit shall be rendered inoperative during Fire Service.

2.10 Car Top Inspection Station

1. Provide station device to operate each elevator from on top of the car during adjustment, inspection, maintenance, and repair.

2. Operating means shall conform to the following:

   a. Device shall be of the continuous-pressure type; operate the car at a speed not exceeding 150 ft/min; operate the car subject to the electrical protective devices required by ASME A17.1 Rule 210.1d.

2.11 Cab Entrances

1. Cab Doors: Stainless steel 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction. Door shall be hung on sheave type hangers with polyurethane tires that roll on a polished track. The hanger shall be provided with adjustable eccentric rollers to take the up-thrust out of the doors. The doors shall be guided at the bottom by non-metallic shoes sliding in the below listed threshold. Fabricate front return panels same as doors.

2. Cab Door Frames: Stainless steel; 0.058-inch (1.5mm) thick metal, standard design with non-detectable joints.


2.12 Accessibility Provisions

1. Comply with applicable code.

   a. Locate highest button in the control panel and highest operable part of the telephone a maximum of 48 inches above floor.

   b. Provide Braille numerals immediately to left of car buttons, DOOR OPEN, DOOR CLOSE and alarm buttons in the control panel to identify each landing. Shall be glued and screwed into position.

   c. Provide handrails on rear of car.

   d. Sound audible signal in car when car is stopping at or passing landing.

   e. Provide stainless steel vandal proof landing lanterns with audible signal when car is arriving at landing; 1 for up stops and 2 for down stops.
2. Provide 2-inch high raised numerals and Braille on each landing jamb to identify landing number, characters shall be centered 60 inches above floor.

2.13 Hoistway Entrances

1. **Hoistway Doors:** Stainless steel; 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction.

2. **Hoistway Door Frames:** Stainless steel; 0.058-inch (1.5 mm) thick metal, of rolled profiles, standard offset bolted design with non-detectable joints.

3. **Door and Frame Construction:** 1-1/2 hour fire rating; insulated sandwich panel door construction 1-1/4 inch (32mm) thick, minimum.

4. **Door Hangers:** Furnish and install sheave type two point suspension hangers and tracks. The sheaves shall have polyurethane tires with ball bearings properly sealed to retain grease. The hangers shall be provided with adjustable eccentric rollers to take the up-thrust of the doors. The tracks shall be drawn steel shapes, smooth surface and shaped to conform to the hanger sleeves.

5. **Sills:** “U” shaped saddles.
   
a. **Material:** Extruded aluminum, except provide nickel silver at egress floor.

6. **Interlocks:** Each hoistway entrance shall be equipped with an approved type of interlock that has been tested as required by the appropriate code. The interlock shall be designed to prevent operation of the car away from the landing until the doors are locked in the closed position, and shall prevent opening the doors at any landing from the corridor side without the use of a special tool. Interlocks shall bear Underwriters’ Laboratories “B” label of approval.

7. Hoistway door-unlocking devices shall be provided on all floors and comply with ASME A17.1. These devices shall permit authorized personnel to gain access to the hoistway when the elevator car is away from the landing.

2.14 Landing Controls

1. **Landing Buttons:** Vandal-resistant stainless steel Illuminating type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows, including indications required by ASME A17.1. Hall button covers to be engraved and filled with pictograph detailing “In case of fire use stairs”. Accepted alternate “Cast Appendix H” inset to face plate as manufactured by Stencil Cutting & Supply Company.

2. **Hall Position Indicator:** Through engraved at egress floor.
3. Hall lanterns: Through engraved.

4. All screws to be pin in hex tamper proof.

2.15 Finishes

1. **Structural Metal Surfaces:** Clean surfaces of rust, oil or grease; wipe clean with solvent; prime and paint.

2. **Machine Room Components:** Clean and degrease; prime one coat, finish with one coat of enamel.

3. **Galvanized Surfaces:** Clean with neutralizing solvent; prime one coat.

4. **Aluminum:** Mill finish.

5. **Wood Surfaces not Exposed to Public View:** One coat primer; one coat enamel.

6. **Stainless Steel:** #4 Satin.

**PART 3: EXECUTION**

3.01 Installation

1. Install in accordance with ASME A17.1, manufacturer's instructions, and applicable codes.

2. Casing:
   a. Excavate for hydraulic hole casing. Set steel casing in hole free of rocks and other protrusions. Backfill open space between the hole and steel casing with settling sand. The PVC casing shall be of suitable size to allow a minimum annular space of 1-1/2 inches between the PVC and steel casing. After plumbing the PVC fill the 1-1/2 inch annular space between the steel casing and PVC casing with settling sand. There shall be a minimum 1-1/2 inch annular space between the PVC casing and the elevator hydraulic jack. PVC casing shall be sealed at the bottom with a schedule 40 PVC cap that fits the casing. The PVC casing shall be brought up to the finish floor level. Following installation of hydraulic jack in the PVC casing, fill the annular space with Union-guard 160 by Pacific Standard Chemical Co. or (Owner approved substitute). Follow Manufacture’s recommended installation procedure. The PVC casing shall be grouted into concrete floor slab with a non-shrinking concrete. There shall be a 1” galvanized nipple installed through the concrete cap into the 1-1/2” annular space between the PVC and hydraulic jack with a bleeder valve mounted on top to monitor the pressure between the PVC and jack. Wrap nipple with electrical tape.
   b. Prior to installing jack, remove water and debris from PVC casing.
c. Double wrap hydraulic jack with an approved coating designed to protect the unit from electrolytic and chemical corrosion. Any other underground piping shall be similarly protected.

d. Install jack assembly plumb, centered, and shimmed; use centering lugs to prevent displacement.

e. Following installation of hydraulic jack in the PVC casing, fill the annular space with Union-guard 160 by Pacific Standard Chemical Co.(or Owner approved substitute. Follow Manufactures recommended installation procedure.

3. Arrange equipment in machine room so that elements requiring removal or maintenance are readily accessible without disturbing other components. Arrange for clear passage between components.

4. Install system components. Connect equipment to building utilities.

5. Mount motor and pump unit on vibration and acoustic isolators, equal to type ND by Mason Industries. Securely fasten to building supports; prevent lateral displacement.

6. Install and connect piping between machine and cylinder.

7. Install guide rails to compensate for expansion and contraction movement.

8. Accurately machine and align guide rails. Form smooth joints with machined splice plates.

9. Install hoistway door thresholds, frames, and headers in hoistway walls. Set entrances in vertical alignment with car openings and plumb hoistway lines.

10. Grout thresholds.

11. Adjust equipment for smooth and quiet operation.

12. Clean field welds; remove oxidation and residue. Apply touch up primer.

3.02 Erection Tolerances

1. Quality Control: Tolerances.

2. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.2.

3. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.
3.03 Field Quality Control

1. Quality Control: Field inspection, testing, adjusting, and balancing.

2. Perform tests required by ASME A17.1 and ASME A17.2.2.

3. Test elevator in presence of Owner and Architect to ensure proper operation and compliance with specified requirements; make final adjustments as appropriate.

4. Obtain inspections and permits and make such tests as are required by governing authorities. Deliver test certificates and permits to Owner.

5. Provide two weeks written notice of date and time of tests.

6. Supply instruments and execute specific tests.

3.04 Tests By Regulatory Agencies

QEI Certified Testing in accordance with ASME A17.1 will be performed by Owner.

3.05 Adjusting


2. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.

3. Adjust automatic floor leveling feature at each floor to achieve (+/-) 1/8 inch (3mm) from floor level.

3.06 Cleaning

1. Contract Closeout: Cleaning installed work.

2. Remove protective coverings from finished surfaces.

3. Clean surfaces and components ready for inspection.

3.07 Protection Of Finished Work


2. Do not permit construction traffic within cab after cleaning.

END OF STANDARD 14255
PART 1: GENERAL

1.01 Summary

1. Section Includes:
   a. Electric traction passenger elevator system.
   b. Passenger cab, interior finishes, control panel and facings including cab doors.
   c. Fire rated hoistway doors, sills, and frames.
   d. Guide rails and brackets, hoisting cables, brake, safety and governor, and counterweights.
   e. Pit buffers.
   f. Motors, variable voltage variable frequency drive, microprocessor type control system, power supply, and accessories.

2. Related Sections:
   a. Construction Facilities and Temporary Controls: Temporary power supply.
   b. Cast-in-Place Concrete: Reinforced concrete shafts.
   c. Unit Masonry System: Masonry for fire rated shafts and hoistway openings.
   d. Structural Steel: Structural hoist, divider, and sheave beams and other steel items.
   e. Metal Fabrications: Pit ladder and accessories.
   f. Plumbing Fixtures: Pit drainage.
   g. Panelboards: Electrical power to the machine room including main switch and breaker. Heat and smoke sensing devices.

3. Work Required by Other Sections:
   a. The contractor shall coordinate all work required by latest applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
   b. The machine room shall be enclosed and conditioned per the elevator manufacturer’s required tolerances and have temporary power available for installation work.
   c. Crane service shall be provided for the hoisting of the machine room equipment.
   d. All structural beams and rails shall be in place.
   e. The elevator pit shall include ladder, guarded light, GFI receptacle and sump pump with cover. Light and pump shall each be on separate dedicated circuits.
   f. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of
Form C contacts, which shall change state when electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts, which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designated as the pre-transfer signal.

1.02 References

1. American Architectural Manufacturers Association (AAMA):

2. American Society of Mechanical Engineers (ASME):


   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
   h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   i. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, General Requirements.
   k. B209: Aluminum-Alloy Sheet and Plate.
   l. B221: Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and tubes.
   m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.
5. National Electrical Manufacturer's Association (NEMA):
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.


8. Other:
   b. AWS D1.1: Structural Welding Code.
   d. ANSI/IEEE 519: Electrical harmonic requirements.

1.03 System Description

1. Characteristics of Elevator No. (#) as follows:
   a. **Type:**
      Electric geared traction. (Select One: Top mounted machine room or Offset mounted machine room.)
   b. **Control:**
      1. **General Supervisory:** Shall operate in real time and continuously analyze each car’s changing position, condition, and workload. The microprocessor shall continuously scan the system for hall calls. When the hall calls are registered, the control system shall instantly calculate the estimated time of arrival for each car to each assigned hall call. The following factors shall be used in calculating the estimated time of arrival: number of floors to travel from the current position, the time it takes to travel one floor at top speed, calls assigned to a car, and car reversal time to respond to a call in the opposite direction of travel. An internal constant shall be set, requiring a maximum time for a car to respond to a call. When a car’s status changes or additional hall calls are registered, the estimated time of arrival shall be recalculated and calls reassigned if necessary.

      2. **Traffic Pattern:** The microprocessor shall provide flexibility to meet well defined patterns of traffic such as
up peak, down peak, and heavy interfloor demands and still adjust for the many indeterminate variations in these patterns which occur in buildings.

3. **Load Weighing Device:** Each car shall be provided with a load weighing device which, when the particular car is filled to an adjustable percentage of the capacity load, shall cause the car to bypass the landing calls but not the car calls. These passed landing calls shall remain registered for the next following car. The device shall be unaffected by the action of compensating chain or rope. A suitable sensor shall accurately measure the weight of the car. This information shall be inputted into the elevator controller. The device shall be capable of detecting an approximate 15-pound load change under all conditions.

4. **Anti-Nuisance Call Control:** The microprocessor control system shall evaluate the number of people on the car and compare that value to the number of car calls registered. If the number of car calls exceeds the number of people by a field programmable value, the car calls shall be canceled after the first call has been answered.

5. **Position Selection:** The position selector shall be part of the microprocessor system. The car position in the hoistway shall be digitized through a primary position encoder. The microprocessor control system shall store the floor, the position, and slowdown points in memory.

6. **Motion Control:** The drive control system shall be a system based primarily on car position. The velocity profile shall be calculated by the microprocessor control system producing extremely smooth and accurate stops. The velocity encoder shall permit continuous comparison of machine speed to the velocity profile and to actual car speed. This accurate position/velocity feedback shall permit a fast and accurate control of acceleration and retardation.

7. **Door Standing Time Saver:** The system shall be capable of resetting the door open time upon interruption of the electronic detector prior to the expiration of the initial door open time.

c. **Power Characteristics:** For elevator drive apparatus: (##) HP, 480 Volt, three-phase 60 Hz. For lighting: 120 Volt, 60 Hz.
d. **Drive System:** Variable voltage variable frequency (VVVF).
e. Rated Net Capacity: (###) lbs. (###kg).
f. Rated Speed: (###) ft/min (#m/s).
g. Car Interior Dimensions: (#'-#") wide x (#'-#") deep.
h. Cab Height: (#'-#”).
i. Cab Clear Ht. to suspended ceiling: (#'-#”).
j. Hoistway and Cab Entrance Frame opening size: (#'-#") x (#'-#”).
k. Door Type/Operation: Select one: center opening, single slide; center opening, two speeds; single slide; single slide, two speeds.
l. No. of Stops: Number (#) stops; Travel distance: (#'-#”).
m. No. of Openings: Number (#); (#) at front and (#) at rear.

2. Operation (Select one):
1. Simplex Collective.
2. Duplex Collective.
3. Group microprocessor controlled demand allocation.

3. Programmable controls shall allow: When car without registered car calls arrives at floor where both up and down calls are registered, initially respond to hall call in direction of travel. If no car or hall call is registered for future travel in that direction, respond to hall call in opposite direction.

4. Hall lanterns:
   a. A stainless steel vandal proof hall lantern with an audible signal shall be installed at each landing entrance for each elevator. The lanterns, when illuminated, shall indicate the elevator car, which shall stop at the landing and in which direction the car, is set to travel.
   b. As soon as a car has reached a predetermined distance from a floor at which it is going to stop, the corresponding hall lateen shall be illuminated and the signal shall sound. The hall lateen shall remain illuminated until the car doors close in preparation for leaving the floor.
   c. Provide thru-engraved vandal resistant design.

5. Door Operation and Control Features:
   a. Furnish a direct current motor driven heavy-duty operator. Operator shall be compatible with MCE Controller and adjustable with out the use of proprietary tools. The system shall be designed to operate the car and hoistway doors simultaneously. Door movements shall be electrically cushioned at both limits of travel and the door operating mechanism shall be arranged for manual operation in the event of a power failure. A door protection system using microprocessor controlled infrared light beams (Janis or Microscan or equal) shall be provided. The beams shall
project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen. A mechanical reopening device shall not be provided. Doors shall automatically open when the car arrives at the landing and shall automatically close after an adjustable time interval or when car is dispatched to another landing. Direct drive geared operators, A.C. controlled units with oil checks, or other deviations of these are not acceptable.

b. If the electronic detector is activated when the doors are closing and the doors are more than one-third closed, they shall reverse direction and open only partially. The doors shall begin to reclose when the electronic detector is deactivated. The doors shall reopen fully if the electronic detector is activated longer than a fixed time.

c. Nudging:
   The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If the door movement is obstructed longer than a field programmable time value, a buzzer shall sound and the doors shall close at a reduce speed.

d. The current door hold time shall be changed to a shorter field programmable time when the door protection system is activated.

e. The microprocessor control system shall provide separate timers for car call door hold open time and hall car door hold open time. The door hold open times shall be field programmable.

6. Electric limit switches: There shall be limit switches placed in the hoistway near the terminal landings and be designed to cut off the electric current and stop the car should it run beyond either terminal landing.

7. Automatic Self-Leveling: The elevator shall be provided with a self-leveling feature that will automatically bring the car to the floor landings. This feature shall be entirely automatic and independent of the operating device and shall correct for overtravel or undertravel. The car shall be maintained level with the landing irrespective of the load.

1.04 Fireman's Service

1. Provide "Firefighter's Operation" in accordance with the latest ASME A17.1.
   a. Interconnect elevator control system with building fire alarm, and smoke alarm system.
b. Designated Landing: Egress Floor.

2. Seismic Design: In accordance with applicable code.

1.05 Independent Service

1. Provide "Independent Service toggle Switch" in service cabinet in car. Activation will remove that car from normal operation and cancel all pre-registered car calls and hall calls for that car.

2. Car will respond to selected floor. Car will not respond to any calls from hall call buttons. Car will only respond to calls placed on the car-operating panel. Doors will remain open at last landing requested. Doors will close with a constant pressure on "DOOR CLOSE" button.

3. Toggle switch activation to normal will return car to normal operation.

1.06 Emergency Electrical Operation

1. Interconnect elevator control system with building emergency electrical supply.

a. In the event of a normal power failure, the elevator system shall be designed to operate from the emergency electrical supply. The elevator controls shall receive an input indicating that the electrical supply is from the emergency source. The elevator controls shall then allow one unit at a time to be lowered to the egress level, open the doors, and become inactivated.

b. After all of the elevators have been lowered and become inactivated, one selected unit shall resume operation on the emergency electrical system. In the event that the selected unit fails, after a set time delay the next elevator in line shall assume operation.

c. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of (Form “C”) contacts, which shall change state when the electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts, which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designed as the pre-transfer signal. This may not be used at any time of installation of the equipment but must be available for future use.

d. Once normal power is restored, the elevator controls shall return all units to normal operation.
1.07 Submittals For Review
Submit under provisions established in the project specifications, Division One requirements.

1. Provide a signed copy of The University of Texas ENVIRONMENTAL HEALTH AND SAFETY CONSTRUCTION SITE PROCEDURES FOR CONTRACTORS, prior to commencement of any work.

2. **Shop Drawings:** Include following information:
   a. Motor, brake, drive system, valves, controller, selector, governor, and other component locations.
   b. Car, machine beams, guide rails, buffers, wire ropes, counterweights and other components in hoistway.
   c. Rail bracket spacing and maximum loads imposed on guide rails requiring transfer to structure.
   d. Individual weight of principle components and load reactions at points of support.
   e. Loads on hoisting beams.
   f. Clearances and over travel.
   g. Locations of components in machine room. Show arrangement so that moving elements and other equipment can be removed for repairs without disturbing other components. Arrange equipment for clear passage through doors and access doors.
   h. Location in hoistway and machine room of connections for car light and telephone.
   i. Locations of access doors, doors, and frames.
   j. Expected heat dissipation of elevator equipment in machine room.
   k. Electrical characteristics and connection requirements.

3. **Samples:** Illustrate cab interior finishes and car and hoistway door and frame finishes.
1.08 Submittals At Project Close-out


2. Furnish two copies of bound maintenance manuals for each elevator. Include full maintenance and operating instructions, parts list, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams.

3. Include legible schematic of all wiring diagrams of installed electrical equipment and changes made in the work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

4. Provide two copies of master electric schematics and one copy of lubrication chart.

5. Tools, electrical prints, parts catalogs, keys, door keys, protective cab pads and other proprietary components shall be turned over to The University of Texas Utilities Service Elevator Inspection Department, upon final inspection of the elevator.

1.09 Quality Assurance

1. Perform Work in accordance with the latest ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section.

2. Fabricate and install door and frame assemblies in accordance with NFPA 80 and UL 10B.

3. Qualifications:
   a. Contractor:
      1. Maintain a warehouse and maintenance service in the City of Austin, Texas.
      2. Minimum (5) years, prior to bid date of this project, in the business of providing elevator service and having warehouse facilities.
      3. Maintain in Austin, Texas an adequate stock of parts for emergency and replacement purposes.
      4. Qualified personnel available at Austin, Texas to insure fulfillment of maintenance and/or repair service on a 24-hour emergency call basis.

   4. Installer: Employees and supervisor on payroll of elevator equipment manufacturer.
5. **Equipment:** Manufactured and guaranteed by the selling company; manufactured in its entirety (exclusive of cabs and doors) by the designer and manufacturer.

6. **Parts, accessories, and appurtenances:** Erected, installed, adjusted, tested and placed in operation by competent mechanics skilled in this work and under the direct control and supervision of the Installers experienced foreman.

### 1.10 Regulatory Requirements

1. Conform to the latest ASME A17.1 code for manufacture and installation of elevator system.

2. Conform to Texas Department of Licensing and Regulation’s (TDLR) Texas Accessibility Standards (TAS) for provisions for the disabled.

3. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

### 1.11 Warranty


2. Correct defective Work within a 90 days period after Date of Substantial Completion.

3. **Warranty:** Include coverage for elevator operating equipment and devices.

### 1.12 Maintenance Service


2. Provide service and maintenance of elevator system and components for Ninety Days (90) from Date of Final Acceptance of last elevator.

3. Examine system components semi-monthly. Clean, adjust, and lubricate equipment.

4. Include systematic examination, adjustment, and lubrication of elevator equipment. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.
a. Include monthly Fire Service, and emergency light inspections and test.
b. Include Hoistway sills and Car sills.
c. Include elevator cab handrails.

5. Perform work without removing cars during peak traffic periods.

6. Maintain in Austin, Texas an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24-hour emergency call basis for this maintenance period.

7. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer.

8. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

1.13 Extra Materials


2. Supply three extra keys for each keyed switch.

3. Submit two (2) copies of bound maintenance manual for each elevator to Owner. Include full maintenance and operating instructions, parts lists, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams. Turn over to the owner for their use, all service tools and diagnostic devices required for adjusting and trouble shooting purposes. Include updates or modifications of test equipment for 10 years.

PART 2: PRODUCTS

2.01 Manufacturers

1. Contract Documents are based on (List Model #) by (List Company).

2. Equivalent products by the following are acceptable:

   a. Motion Control Engineering
   b. Thyssen/Dover
   c. KONE Inc.
   d. Tejas Elevator
e. United Technologies Otis Elevator Company
f. Schindler Elevator Corp
g. Elevator Products Corp
h. Innovation Industries Corp
i. Hollister Whitney Elevator Corp
j. PTL Car & Hall Fixtures
k. Owner approved equal

3. Substitutions: Under provisions of Section 0####.

2.02 Materials

1. Steel:
   b. Sheet: ASTM A 446, galvanized, stretcher leveled, Commercial Grade.

2. Stainless Steel: ASTM A 167, Type 302 or 304, No. 4 satin/brushed finish.

   a. Extrusions: ASTM B 221.

4. Plywood: APA Structural I, Grade C-D, sanded.

5. Plastic Laminate: NEMA LD-3, General Purpose Type.

6. Paints:
   a. Primer for steel: Red Oxide.
   b. Primer for wood: Alkyd primer/sealer.
   c. Enamel: Semigloss alkyd.

2.03 Components

1. Shall include motors, brake, counterweight guides and guide shoes, ropes, cables, sheaves, counterweights, safety and governor, controller, controls, buttons, rails, wiring as required by NFPA 70, devices, and indicators. Component parts shall be individually specified below.

2. The machine shall be a geared traction type with motor, brake and traction drive. Sound isolation pads shall be mounted beneath the bed plates.
3. The motor shall be of a design suitable for the anticipated traffic and be rated for a high starting torque and low starting current. The motor shall be suitable for use with a variable voltage variable frequency type system and shall meet ANSI 519 requirements for electrical harmonic distortion.

4. The brake shall be spring applied and electrically released.

5. The elevator shall be provided with automatic self-leveling to a tolerance of (+/-) 1/8 inch and shall correct for travel variations and rope stretch.

6. The elevator shall have an overspeed governor and brake system.

7. Operational Controller:
   a. Motion Control Engineering Inc. (MCE Only). Controller shall be NEMA 1.
   b. Drive Control: (Select one):
      1. PTC
      2. IMC

8. Landing System: Shall be compatible with MCE controller. (Select One):
   a. (LS-QUTE) up to 300 fpm
   b. (LS-QUAD) over 300 fpm

2.04 Electrical System Characteristics

1. Electrical Characteristics:
   a. 480 volts, three-phase, 60 Hz.
   b. Motor Drive Characteristics:
      1. Variable voltage variable frequency system shall allow for soft start type operation.
   c. Refer to Division 16, - Equipment Wiring Systems: Electrical connections.

2.05 Electrical Components

1. Boxes, Conduit, Wiring, and Devices: Required by NFPA 70 and under provisions of Division 16.
2. **Fittings**: Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. **Spare Conductors**: Include 10 percent extra conductors and two pairs of shielded audio cables in traveling cables. Do not parallel conductors to increase electric current capacity unless individually fused.

4. Do not use armored flexible metal conduit as a grounding conductor.

5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine rooms. Provide additional components and wiring to suit machine room layout.

6. All labeling required by ASME A.17.1 shall be of permanently engraved/embossed and permanently affixed plaques. Plaques may be either plastic laminate or metallic. “Permanent Marker” or “Labeling Tape” ID’s shall not be used.

2.06 **Machine**

1. The machine shall be a single worm geared traction type with motor, brake, gearing and driving sheave mounted in the proper alignment on a steel bedplate. Sound isolation pads shall be mounted beneath the bed plates.

2. The worm shall be of hardened and ground steel, integral with the worm shaft, and shall be provided with a ball or roller thrust bearing designed to take the end thrust of the worm in both directions.

3. The ring gear shall be hobbed from a bronze rim, which shall be accurately fitted and bolted to the gear spider.

4. The sheave and gear shall be supported by heavy-duty ball or roller bearings. The roller and anti-friction metal bearings shall be provided with an adequate means of lubrication.

2.07 **Motor**

1. The motor shall be rated A. C., NEMA code letter “G” or as required for the torque and duty requirements. The motor shall be suitable for use with a variable voltage variable frequency type drive.
2. The motor shall be totally enclosed non-ventilated with a class F insulation rating.

3. The armature shall be dynamically balance and supported by ball bearings of adequate capacity.

2.08 Drive Control

1. The elevator drive shall be supplied a variable voltage variable frequency supply from a vector controlled pulse-width modulated alternating current motor drive.

2. The speed control shall be by means of a vector control providing independent excitation and torque current. A digital velocity encoder shall be provided on the motor giving feedback to the controller on motor speed and position.

2.09 Brake

1. The electric brake shall be spring applied. The controller shall actuate the brake and allow smooth, positive stops. The brake shall be designed for automatic application in the event of power supply failure.

2.10 Ropes

1. Provide suitable traction steel hoist ropes of size and number to insure proper wearing qualities.

2. Adequate compensation for weight of hoist ropes to be furnished when required to maintain proper counterbalance ratio.

3. Governor ropes shall be iron.

2.11 Counterweights

1. Each elevator shall be suitably counterbalanced for smooth and economical operation. Cast iron or steel plate weights shall be contained in a structural steel frame.

2. The counterweight shall be equal to the complete elevator car and approximately 40% of the specified load.

2.12 Safety and Governor

1. The car safety shall be mounted on the bottom members of the car frame and shall be operated by a centrifugal speed governor
located over the hoistway. The governor shall be designed to cut off power to the motor and apply the brake whenever the governor indicates the car has excessive speed.

2.13 Lubrication

1. **Grease Fittings:** For lubricating bearings requiring periodic lubrication.

2. **Lubrication Points:** Visible and easily accessible.

2.14 Car Structural Fabrication

1. **Frame:** Fabricated steel frame of formed or structural steel shapes, gusseted and rigidly welded.

2. **Platform:** Fire retardant treated plywood subflooring assembly laid over steel stringers and ready to receive floor finish. The platform shall be completely isolated from the car sling and bracing members by vibration absorbing materials.

3. **Sling:** Shall consist of heavy steel stiles, properly affixed to a steel crosshead and safety channels with adequate bracing members to remove all strain from the car enclosure.

2.15 Cab Fabrication

1. Based on (List Model #) manufactured by (List manufacturer).

2. **Cab Design:** Passenger Elevator:

   a. **Flooring:** Rubber flooring as specified in Section 0####.
   b. **Sides and rear walls:** Plastic laminate.
   c. **Handrails:** Stainless steel, cylindrical profile.
   d. **Front and rear returns and transom:** Stainless steel with No. 4 finish.
   e. **Ceiling:** Translucent suspended.
   f. **Canopy:** Baked enamel on steel.
   g. **Ventilation:** 2 speed blower mounted above ceiling, with grille.
   h. **Lighting:** Fluorescent with solid lens diffuser.
   i. Provide wall hooks and removable protective mats for cab walls.
   j. Provide stainless steel license holders for display of required certificates. Design the holder to use non-visible tamper-proof fastenings. Holder shall enclose an 8 1/2” x 11” sign.
2.16 Car Operating Panel

1. Provide one/two vandal resistant flush mounted operating panel(s) containing illuminated car buttons corresponding to floors served, in car alarm button(s), and DOOR OPEN DOOR CLOSE button(s).

2. Position alarm button where it is unlikely to be accidentally actuated; not less than 35 inches above cab floor.

3. Include matching service cabinet integral with front return panel, with hinged door and lock in each car containing:
   a. Independent service switch. (Toggle Sw.)
   b. Inspection switch. (Toggle Sw.)
   c. Fan or blower switch. (Toggle Sw.)
   d. Light switch. (Toggle Sw.)
   e. Emergency stop switch. (Toggle Sw. or push pull)
   f. Locate a 110 V, 15 Amp GFI convenience receptacle in service cabinet.

4. Flush mounted Telephone:
   a. ADA compliant "hands free" type telephone.
   b. Acceptable manufacturer: Wurtec Inc. Cat. #11-582-VAN, or Owner approved equal.
   c. Engraved and filled lettering on panel; silk screened lettering not acceptable.

5. Additional operating switches for the special features specified.

6. Elevator identification number, 1/2 inch high, engraved and filled. Locate at top of panel.

7. Include an emergency light mounted above the car-operating panel.

2.17 Car And Counterweight Guides and Guide Shoes

1. Guides for the car and counterweight shall be planed steel guide rails, properly fastened to the building structure with steel brackets.

2. Roller guides, consisting of a minimum of three tires, shall be mounted on the top and bottom of the car and counterweight frame, and shall be held in contact with the guide rail by
adjustable devices. Roller guides shall run on dry, unlubricated rails.

2.18 Car Top Inspection Station

1. Provide station device to operate each elevator from on top of the car during adjustment, inspection, maintenance, and repair.

2. Operating means shall conform to the following:
   a. Device shall be of the continuous-pressure type; operate the car at a speed not exceeding 150 ft/min; operate the car subject to the electrical protective devices required by ASME A17.1 Rule 210.1d.

3. Device shall be used only for the purpose of adjustment, inspection, maintenance, and repair of the elevator or hoistway equipment.

4. Provide each elevator with an electric light protected with a guard and a GFI convenience outlet fixture on the car top.

2.19 Cab Entrances

1. **Cab Doors:** Stainless steel 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction. Door shall be hung on sheave type hangers with polyurethane tires that roll on a polished track. The hanger shall be provided with adjustable eccentric rollers to take the up-thrust out of the door. The door shall be guided at bottom by non-metallic shoes sliding in the below listed threshold.

2. **Cab Door Returns:** Stainless steel; 0.058-inch (1.5mm) thick metal, standard design with smooth invisible joints.

3. **Thresholds:** Nickel Silver “U” shaped saddles.

2.20 Accessibility Provisions

1. Comply with applicable code:
   1. Locate highest button in the control panel and highest operable part of the telephone a maximum of 48 inches above floor.
   2. Provide Braille numerals immediately to left of car buttons, DOOR OPEN DOOR CLOSE, and alarm buttons in the control panel to identify each landing or function.
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3. Provide handrails on rear of car.
4. Sound audible signal in car when car is stopping at or passing landing.
5. Provide landing lanterns with audible signal when car is arriving at landing; 1 for up stops and 2 for down stops.

2. Provide 2-inch high raised numerals with Braille on each landing jamb to identify landing number, characters shall be centered 60 inches above floor.

2.21 Hoistway Entrances

1. Hoistway Doors: Stainless steel; 0.058 inch ([1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction.

2. Hoistway Door Frames: Stainless steel; 0.058-inch (1.5 mm) thick metal, of rolled profiles, standard design with smooth invisible joints.

3. Door and Frame Construction: 1-1/2 hour fire rating; insulated sandwich panel door construction 1-1/4 inch (32mm) thick, minimum.

4. Door Hangers: Furnish and install sheave type two point suspension hangers and tracks. The sheaves shall have polyurethane tires with ball bearings properly sealed to retain grease. The hangers shall be provided with adjustable eccentric rollers to take the up-thrust of the doors. The tracks shall be drawn steel shapes, smooth surface and shaped to conform to the hanger sleeves.

5. Sills: “U” shaped saddles.

   a. Material: Extruded aluminum, except provide nickel silver at egress floor.

6. Interlocks: Each hoistway entrance shall be equipped with an approved type of interlock that has been tested as required by the appropriate code. The interlock shall be designed to prevent operation of the car away from the landing until the doors are locked in the closed position, and shall prevent opening the doors at any landing from the corridor side without the use of a special tool. Interlocks shall bear Underwriters’ Laboratories “B” label of approval.
7. Hoistway door-unlocking devices shall be provided on all floors and comply with ASME A17.1. These devices shall permit authorized personnel to gain access to the hoistway when the elevator car is away from the landing.

2.22 Landing Controls

1. **Landing Buttons**: Vandal-resistant stainless steel Illuminating type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows, including indications required by ASME A17.1. Hall button covers to be engraved and filled with pictograph detailing “In case of fire use stairs”. Accepted alternate “Cast Appendix H” inset to face plate as manufactured by Stencil Cutting & Supply Company.

2. **Landing Position Indicators**: Through engraved stainless steel.

3. **Car Direction Indicators**: Through engraved stainless steel.

4. **Screws**: All screws to be pin in hex tamper proof.

2.23 Finishes

1. **Structural Metal Surfaces**: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime and paint.

2. **Machine Room Components**: Clean and degrease; prime one coat, finish with one coat of enamel.

3. **Galvanized Surfaces**: Clean with neutralizing solvent; prime one coat.

4. **Aluminum**: Mill finish.

5. **Wood Surfaces not Exposed to Public View**: One coat primer; one coat enamel.

6. **Stainless Steel**: #4 Satin.

**PART 3: EXECUTION**

3.01 Site Inspection
1. Examine work of other Sections that affects the Elevator System. Report defects that will affect equipment or system operation to the Architect/Engineer.

2. Before fabrication, take job site measurements and verify that Work Required by others is complete. Check measurement of space for equipment and means of access for installation and operation.

3.02 Installation

1. Install in accordance with ASME A17.1, manufacturer's instructions, and applicable codes.

2. Arrange equipment in machine room so that elements requiring removal or maintenance are readily accessible without disturbing other components. Arrange for clear passage between components.

3. Set all hoistway entrances in vertical alignment with car openings and true with plumb sill lines.

4. Install machinery, guides, rails, controls, car and all equipment and accessories to provide for a quiet, smooth operation free of sideways movement, oscillation or vibration.

5. Mount machine directly over hoistway on steel beams or (mount machine adjacent to shaft with transfer pulley over opening). Isolate and dampen vibration with properly sized sound-reducing anti-vibration pads.

6. Erect hoistway sills, headers and frames prior to the erection of rough walls and doors; erect fascia and toe guards after rough walls are finished.

7. Grout sills and hoistway entrance frames.

8. Clean field welds; remove oxidation and residue. Apply touch up primer.

9. Connect equipment to building utilities.

3.03 Erection Tolerances

1. Quality Control: Tolerances.
2. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.1.

3. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.04 Field Quality Control

1. Quality Control: Field inspection, testing, adjusting, and balancing.

2. Perform tests required by ASME A17.1 and A17.2.1.

3. Test elevator in presence of Owner and Architect to ensure proper operation and compliance with specified requirements; make final adjustments as appropriate.

4. Obtain inspections and permits and make such tests as are required by governing authorities. Deliver test certificates and permits to Owner.

5. Provide two weeks written notice of date and time of tests.

3.05 Tests By Regulatory Agencies

1. QEI Certified Testing in accordance with ASME A17.1 will be performed by Owner.

3.06 Adjusting


2. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.

3. Adjust automatic floor leveling feature at each floor to achieve (+/-) 1/4 inch (3mm) from floor level.

3.07 Cleaning

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2. Remove protective coverings from finished surfaces.
3. Clean surfaces and components ready for inspection.

3.08 Protection of Finished Work

2. Do not permit construction traffic within cab after cleaning.

END OF STANDARD 14260
PART 1: GENERAL

1.01 Summary

Section Includes:

1. Electric traction freight elevator system.
2. Passenger cab, interior finishes, control panel and facings including cab doors.
3. Fire rated hoistway doors, sills, and frames.
5. Pit buffers.
6. Motors, variable voltage variable frequency drive, microprocessor type control system, power supply, and accessories.

1.02 Related Sections:

1. Construction Facilities and Temporary Controls: Temporary power supply.
2. Cast-in-Place Concrete: Reinforced concrete shafts.
3. Unit Masonry System: Masonry for fire rated shafts and hoistway openings.
4. Structural Steel: Structural hoist, divider, and sheave beams and other steel items.
5. Metal Fabrications: Pit ladder and accessories.
7. Panelboards: Electrical power to the machine room including main switch and breaker. Heat and smoke sensing devices.

1.03 Work Required by Other Sections:

1. The contractor shall coordinate all work required by latest applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
2. The machine room shall be enclosed and conditioned per the elevator manufacturer’s required tolerances and have temporary power available for installation work.

3. Crane service shall be provided for the hoisting of the machine room equipment.

4. All structural beams and rails shall be in place.

5. The elevator pit shall include ladder, guarded light, GFI receptacle and sump pump with cover. Light and pump shall each be on separate dedicated circuits.

6. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of Form C contacts, which shall change state when electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts, which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designated as the pre-transfer signal.

1.04 References

1. American Architectural Manufacturers Association (AAMA):

2. American Society of Mechanical Engineers (ASME):


   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

i. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, General Requirements.


k. B209: Aluminum-Alloy Sheet and Plate.

l. B221: Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.

5. National Electrical Manufacturer's Association (NEMA):
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.


8. Other:
   b. AWS D1.1: Structural Welding Code.
   d. ANSI/IEEE 519: Electrical harmonic requirements.

1.05 System Description

1. Characteristics of Elevator No. (#) as follows:
   a. Type: Electric geared traction. (Select One: Top mounted machine room or Offset mounted machine room.)
   b. Control: Microprocessor based static type that is software oriented. The system shall operate in real time and continuously analyze each car’s changing position, condition, and workload. Suitable sensors shall be included within the elevator system to input the correct data to the controller. Inputs to be considered include car loading, position, and motion. The controller’s capabilities shall allow for determination of optimum travel time of each elevator with all cars
and calls being considered. The microprocessor shall consider all traffic patterns. The control shall include anti-nuisance type detection and operating measures.

c. Power Characteristics: For elevator drive apparatus: (#) HP, 480 Volt, three-phase 60 Hz. For lighting: 120 Volt, 60 Hz.

d. Drive System: Variable voltage variable frequency (VVVF).

e. Rated Net Capacity: (#####) lbs. (#####kg).

f. Rated Speed: (###) ft/min (.##m/s).

g. Loading Class: “A”.

h. Car Interior Dimensions: (#-#") wide x (#-#") deep. (#-#") height

i. Landing entrances:
   1. Size: (#-#") wide by (#-#") high.
   2. Type: Vertical bi-parting, power operated.
   5. Truckable sill on lower panel.

j. No. of Stops: Number (#) stops; Travel distance: (##'-#").
k. No. of Openings: Number (#); (#) at front and (#) at rear.

2. Operation (Select one):

   a. Simplex Collective.
   b. Duplex Collective.
   c. Group microprocessor controlled demand allocation.

3. Car Gate and Hoistway Door Control Features:

   a. Individual electric operators shall open and close the hoistway doors and car gate at a panel speed of not more than one foot per second without slamming. Limit switches shall be provided to stop the operator motors as the doors approach the limit of travel in opening.

   b. Provisions shall be made for the manual operation of the doors from the car in the event of a power failure.

   c. The door operators shall be arranged to open the door automatically after the car enters the automatic leveling zone at the designated landing.

   d. Each door shall use dual motors.

   e. Provide automatic closing operation, which shall close the gate and door after a field adjustable period of time. Prior to automatic closing, an audible pre-closing signal shall sound to warn the operator. The audible signal shall be accomplished with a solid-state toner. Bells are not acceptable.

   f. Door Safety Devices: soft, mechanical safety edges, quiet in operation, with non-contact reversing light ray. Peelle or Owner approved equivalent. Gates shall be provided with passenger sequence operation.

   g. Door Operators: Individual electric operators.
4. Hall lanterns shall operate to correspond with next direction of travel. When responding to hall call, lantern shall operate to correspond with direction of call being answered.

5. Electric limit switches shall be placed in the hoistway near the terminal landings and be designed to cut off the electric current and stop the car should it run beyond either terminal landing.

6. The elevator shall be provided with a self-leveling feature that will automatically bring the car to the floor landings. This feature shall be entirely automatic and independent of the operating device and shall correct for overtravel or undertravel. The car shall be maintained level with the landing irrespective of the load.

7. Interconnect elevator control system with building emergency electrical supply.

1.06 Fireman's Service

1. Provide "Firefighter's Operation" in accordance with the latest ASME A17.1.
2. Designated Landing: Egress Floor.
3. Seismic Design: In accordance with applicable code.

1.07 Emergency Electrical Operation

1. Interconnect elevator control system with building fire alarm, and smoke alarm system.
   a. In the event of a normal power failure, the elevator system shall be designed to operate from the emergency electrical supply. The elevator controls shall receive an input indicating that the electrical supply is from the emergency source. The elevator controls shall then allow one unit at a time to be lowered to the egress level, open the doors, and become inactivated.
   b. After all of the elevators have been lowered and become inactivated, one selected unit shall resume operation on the emergency electrical system. In the event that the selected unit fails, after a set time delay the next elevator in line shall assume operation.
   c. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of (Form “C”) contacts, which shall change state when the electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts, which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designed as the pre-transfer signal. This may not be used at any time of installation of the equipment but must be available for future use.
d. Once normal power is restored, the elevator controls shall return all units to normal operation.

1.08 Submittals for Review

Submit under provisions established in the project specifications, Division One requirements:

1. Provide a signed copy of The University of Texas ENVIRONMENTAL HEALTH AND SAFETY CONSTRUCTION SITE PROCEDURES FOR CONTRACTORS, prior to commencement of any work.

2. Shop Drawings: Include following information:
   a. Motor, brake, drive system, valves, controller, selector, governor, and other component locations.
   b. Car, machine beams, guide rails, buffers, wire ropes, counterweights and other components in hoistway.
   c. Rail bracket spacing and maximum loads imposed on guide rails requiring transfer to structure.
   d. Individual weight of principle components and load reactions at points of support.
   e. Loads on hoisting beams.
   f. Clearances and over travel.
   g. Locations of components in machine room. Show arrangement so that moving elements and other equipment can be removed for repairs without disturbing other components. Arrange equipment for clear passage through doors and access doors.
   h. Location in hoistway and machine room of connections for car light and telephone.
   i. Locations of access doors, doors, and frames.
   j. Expected heat dissipation of elevator equipment in machine room.
   k. Electrical characteristics and connection requirements.

3. Samples: Illustrate cab interior finishes and car and hoistway door and frame finishes.

1.09 Submittals at Project Close-out


2. Furnish two copies of bound maintenance manuals for each elevator. Include full maintenance and operating instructions, parts list, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams.
3. Include legible schematic of all wiring diagrams of installed electrical equipment and changes made in the work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

4. Provide two copies of master electric schematics and one copy of lubrication chart.

5. Tools, electrical prints, parts catalogs, keys, door keys, protective cab pads and other proprietary components shall be turned over to The University of Texas Utilities Service Elevator Inspection Department, upon final inspection of the elevator.

1.10 Quality Assurance

1. Perform Work in accordance with the latest ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section.

2. Fabricate and install door and frame assemblies in accordance with NFPA 80 and UL 10B.

3. Qualifications:

   a. Contractor:

      1. Maintain a warehouse and maintenance service in the City of Austin, Texas.
      2. Minimum (5) years, prior to bid date of this project, in the business of providing elevator service and having warehouse facilities.
      3. Maintain in Austin, Texas an adequate stock of parts for emergency and replacement purposes.
      4. Qualified personnel available at Austin, Texas to insure fulfillment of maintenance and/or repair service on a 24-hour emergency call basis.

   b. Installer: Employees and supervisor on payroll of elevator equipment manufacturer.

   c. Equipment: Manufactured and guaranteed by the selling company; manufactured in its entirety (exclusive of cabs and doors) by the designer and manufacturer.

   d. Parts, accessories, and appurtenances: Erected, installed, adjusted, tested and placed in operation by competent mechanics skilled in this work and under the direct control and supervision of the Installers experienced foreman.
1.11 Regulatory Requirements

1. Conform to the latest ASME A17.1 code for manufacture and installation of elevator system.

2. Conform to State of Texas Accessibility Standards for provisions for the disabled.

3. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

1.12 Warranty


2. Correct defective Work within a one-year period after Date of Substantial Completion.

3. Warranty: Include coverage for elevator operating equipment and devices.

1.13 Maintenance Service


2. Provide service and maintenance of elevator system and components for Ninety Days (90) from Date of Final Acceptance of last elevator.


4. Include systematic examination, adjustment, and lubrication of elevator equipment. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.
   a. Include monthly Fire Service and emergency light Inspections and test.
   b. Include elevator cab handrails.

5. Perform work without removing cars during peak traffic periods.

6. Maintain in Austin, Texas an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24-hour emergency call basis for this maintenance period.
7. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer.

8. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

1.14 Extra Materials
2. Supply three extra keys for each keyed switch.
3. Supply hand held computer and other components necessary to test and maintain elevator and equipment. Include updates or modifications of test equipment for 10 years.

PART 2: PRODUCTS

2.01 Manufacturers
1. Contract Documents are based on (List Model #) by (List Company).
2. Equivalent products by the following are acceptable:
   a. Motion Control Engineering
   b. Thyssen/Dover
   c. KONE Inc.
   d. Tejas Elevator
   e. United Technologies Otis Elevator Company.
   f. Schindler Elevator Corp.
   g. Elevator Products Corp
   h. Innovation Industries Corp
   i. Hollister Whitney Elevator Corp.
   j. PTL Car & Hall Fixtures
   k. Owner approved equal.

3. Substitutions: Under provisions established in the project specifications, Division One requirements:

2.02 Materials
1. Steel:
   b. Sheet: ASTM A 446, galvanized, stretcher leveled, Commercial Grade.
2. **Stainless Steel:** ASTM A 167, Type 302 or 304, No. 4 satin/brushed finish.

3. **Aluminum:** Anodizing quality.
   a. Extrusions: ASTM B 221.

4. **Plywood:** APA Structural I, Grade C-D, sanded.

5. **Plastic Laminate:** NEMA LD-3, General Purpose Type.

6. **Paints:**
   a. Primer for steel: Red Oxide.
   b. Primer for wood: Alkyd primer/sealer.
   c. Enamel: Semigloss alkyd.

### 2.03 Components

1. Shall include motors, brake, counterweight guides and guide shoes, ropes, cables, sheaves, counterweights, safety and governor, controller, controls, buttons, rails, wiring as required by NFPA 70, devices, and indicators. Component parts shall be individually specified below.

2. The machine shall be a geared traction type with motor, brake and traction drive. Sound isolation pads shall be mounted beneath the bedplates.

3. The motor shall be of a design suitable for the anticipated traffic and be rated for a high starting torque and low starting current. The motor shall be suitable for use with a variable voltage variable frequency type system and shall meet ANSI 519 requirements for electrical harmonic distortion.

4. The brake shall be spring applied and electrically released.

5. The elevator shall be provided with automatic self-leveling to a tolerance of (+/-) 1/4 inch and shall correct for travel variations and rope stretch.

6. The elevator shall have an overspeed governor and brake system.

7. **Operational Controller:**
SECTION 14265 - ELECTRIC FREIGHT ELEVATOR
CONSTRUCTION STANDARD

a. Motion Control Engineering (MCE) Only. Controller shall be NEMA 1
b. Drive Control: (Select one):
   1. PTC
   2. IMC

8. Landing System: Shall be compatible with MCE controller (Select One):
   a. (LS-QUTE) up to 300 fpm
   b. (LS-QUAD) over 300

2.04 Electrical System Characteristics

1. Electrical Characteristics:
   a. 480 volts, three-phase, 60 Hz.
   b. Motor Drive Characteristics:
      1. Variable voltage variable frequency system shall allow for soft start type operation.
      c. Refer to Division 16, - Equipment Wiring Systems: Electrical connections.

2.05 Electrical Components

1. Boxes, Conduit, Wiring, and Devices: Required by NFPA 70 and under provisions of Division 16.

2. Fittings: Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. Spare Conductors: Include 10 percent extra conductors and two pairs of shielded audio cables in traveling cables. Do not parallel conductors to increase electric current capacity unless individually fused.

4. Do not use armored flexible metal conduit as a grounding conductor.

5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine rooms. Provide additional components and wiring to suit machine room layout.

6. All labeling required by ASME A.17.1 shall be permanently engraved/embossed and permanently affixed plaques. Plaques may be
either plastic laminate or metallic. “Permanent Marker” or “Labeling Tape” ID’s shall not be used.

2.06 Machine

1. The machine shall be a single worm geared traction type with motor, brake, gearing and driving sheave mounted in the proper alignment on a steel bedplate. Sound isolation pads shall be mounted beneath the bedplates.

2. The worm shall be of hardened and ground steel, integral with the worm shaft, and shall be provided with a ball or roller thrust bearing designed to take the end thrust of the worm in both directions.

3. The ring gear shall be hobbed from a bronze rim, which shall be accurately fitted and bolted to the gear spider.

4. The sheave and gear shall be supported by heavy-duty ball or roller bearings. The roller and anti-friction metal bearings shall be provided with an adequate means of lubrication.

2.07 Motor

1. The motor shall be rated A. C., NEMA code letter “G” or as required for the torque and duty requirements. The motor shall be suitable for use with a variable voltage variable frequency type drive.

2. The motor shall be totally enclosed non-ventilated with a class F insulation rating.

3. The armature shall be dynamically balance and supported by ball bearings of adequate capacity.

2.08 Drive Control

1. The elevator drive shall be supplied a variable voltage variable frequency supply from a vector controlled pulse-width modulated alternating current motor drive.

2. The speed control shall be by means of a vector control providing independent excitation and torque current. A digital velocity encoder shall be provided on the motor giving feedback to the controller on motor speed and position.

2.09 Brake

1. The electric brake shall be spring applied. The controller shall actuate the brake and allow smooth, positive stops. The brake shall be designed for automatic application in the event of power supply failure.
2.10 Ropes

1. Provide suitable traction steel hoist ropes of size and number to insure proper wearing qualities.

2. Adequate compensation for weight of hoist ropes to be furnished when required to maintain proper counterbalance ratio.

3. Governor ropes shall be iron.

2.11 Counterweights

1. Each elevator shall be suitably counterbalanced for smooth and economical operation. Cast iron or steel plate weights shall be contained in a structural steel frame.

2. The counterweight shall be equal to the complete elevator car and approximately 40% of the specified load.

2.12 Safety and Governor

1. The car safety shall be mounted on the bottom members of the car frame and shall be operated by a centrifugal speed governor located over the hoistway. The governor shall be designed to cut off power to the motor and apply the brake whenever the governor indicates the car has excessive speed.

2.13 Lubrication

1. **Grease Fittings:** For lubricating bearings requiring periodic lubrication.

2. **Lubrication Points:** Visible and easily accessible.

2.14 Car Structural Fabrication

1. **Frame:** Fabricated steel frame of formed or structural steel shapes, gusseted and rigidly welded.

2. **Platform:** Aluminum checkered plate, 1/4” thick laid over steel stringers and subflooring. The platform shall be completely isolated from the car sling and bracing members by vibration absorbing materials.

3. **Sling:** Shall consist of heavy steel stiles, properly affixed to a steel crosshead and safety channels with adequate bracing members to remove all strain from the car enclosure.

2.15 Cab Fabrication

1. **Cab Design:**
SECTION 14265 - ELECTRIC FREIGHT ELEVATOR
CONSTRUCTION STANDARD

a. **Cab Size**: Platform (#'-#")X(#'-#") Floor to ceiling (#'-#").
b. **Flooring**: Aluminum checkered plate, 1/4" thick.
c. **Car Gate**: Single Blade, expanded metal, power operated.
d. **Sides and rear**: Rigidized (stainless steel) (steel) panels with (diamond pattern) (14 gauge steel).
e. **Ceiling**: Baked enamel on 14-gauge steel.
f. **Ventilation**: 2 speed blower mounted above ceiling, with grille.
g. **Lighting**: Fluorescent with solid lens diffuser.
h. **Controls and fixtures**:
   1. Operating panel flush mounted vandal resistant in side wall.
   2. Telephone Flush mount.
   3. Car position indicator.
   4. Emergency light mounted above car operating panel.

i. Provide stainless steel license holders for display of required certificates. Design the holder to use non-visible tamper-proof fastenings. Holder shall enclose an 8 1/2” x 11” sign.

2.16 Car Operating Panel

1. Provide one flush mounted vandal resistant operating panel containing illuminated car buttons corresponding to floors served, in car alarm button, and DOOR OPEN, DOOR CLOSE buttons. Constant pressure on the CLOSE button shall close the door. Momentary pressure on the OPEN button shall re-open the door, provided the car is at a landing.

2. Position alarm button and emergency stop switch not less than 35 inches above cab floor where it is unlikely to be accidentally actuated. Emergency stop, push-pull or toggle type shall activate alarm or bell when operated.

3. Mounted In Car Operating Panel

   a. Independent service switch (key operated).
   b. Fan or blower switch (key operated).
   c. Light switch (key operated).
   d. Emergency light mounted above car operating panel.
   e. ADA Flush mounted telephone; Wurtec Inc. Cat. 11-582-van, or owner approved equal.
   f. Additional operating switches for the special features specified.
   g. Elevator identification number, 1/2 inch high, engraved and filled. Locate at top of panel.

4. Locate a 110 V, 15 Amp GFI convenience receptacle in car panel.
5. **DOOR HOLD OPEN PUSH BUTTON** to be included. When activated by momentary pressure, the doors shall remain open for an adjustable period of time (1-180 seconds). This extended door open time will be canceled by activation of the **DOOR CLOSE** button. This circuit shall be rendered inoperative during Fire Service.

### 2.17 Car and Counterweight Guides And Guide Shoes

1. Guides for the car and counterweight shall be planed steel guide rails, properly fastened to the building structure with steel brackets.

2. Roller guides, consisting of a minimum of three tires, shall be mounted on the top and bottom of the car and counterweight frame, and shall be held in contact with the guide rail by adjustable devices. Roller guides shall run on dry, unlubricated rails.

### 2.18 Car Top Inspection Station

1. Provide station device to operate each elevator from on top of the car during adjustment, inspection, maintenance, and repair.

2. **Operating means shall conform to the following:**
   a. Device shall be of the continuous-pressure type; operate the car at a speed not exceeding 150 ft/min; operate the car subject to the electrical protective devices required by ASME A17.1 Rule 210.1d.

3. Device shall be used only for the purpose of adjustment, inspection, maintenance, and repair of the elevator or hoistway equipment.

4. Provide each elevator with an electric light protected with a guard and a GFI convenience outlet fixture on the car top.

### 2.19 Cab Entrances

1. **Car Gate:** Single Blade expanded metal, power operated, 6’-0” height. With standard returns.

2. Gates shall be provided with soft mechanical safety edge and a non-contact reversing edge, Peelle or Owner approved equivalent, and with passenger sequence operation.

### 2.20 Accessibility Provisions

1. Comply with applicable code.

### 2.21 Hoistway Entrances
1. Hoistway Doors shall be Peelle doors (OR OWNER APPROVED EQUIVALENT) Prime painted steel vertical bi-parting; 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction, 4”x12” tempered glass vision panel.

2. Hoistway Door Frames: Steel channel specified under provisions established in project specifications, Division Two requirements.

3. Door Construction: 1-1/2 hour fire rating; insulated sandwich panel door construction 1-1/4 inch (32mm) thick, minimum; Truckable sill on lower door panel.

4. Sills: Steel edge angle specified under provisions established in project specifications, Division Two requirements.

2.22 Landing Controls

1. Landing Buttons: Vandal-resistant stainless steel Illuminating type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows, including indications required by ASME A17.1. Hall button covers to be engraved and filled with pictograph detailing “In case of fire use stairs”. Accepted alternate “Cast Appendix H” inset to face plate as manufactured by Stencil Cutting & Supply Company.

2. DOOR OPEN, DOOR CLOSE buttons. Vandal-resistant type. Constant pressure on the CLOSE button shall close the door. Momentary pressure on the OPEN button shall re-open the door, provided the car is at a landing.

3. Screws: All screws to be pin in hex tamper proof.

2.23 FINISHES

1. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime and paint.

2. Machine Room Components: Clean and degrease; prime one coat, finish with one coat of enamel.

3. Galvanized Surfaces: Clean with neutralizing solvent; prime one coat.


5. Wood Surfaces not Exposed to Public View: One coat primer; one coat enamel.
6. **Stainless Steel: #4 Satin.**

**PART 3: EXECUTION**

3.01 Site Inspection

1. Examine work of other Sections that affects the Elevator System. Report defects that will affect equipment or system operation to the Architect/Engineer.

2. Before fabrication, take job site measurements and verify that Work Required by Others is complete. Check measurement of space for equipment and means of access for installation and operation.

3.02 Installation

1. Install in accordance with ASME A17.1, manufacturer's instructions, and applicable codes.

2. Arrange equipment in machine room so that elements requiring removal or maintenance are readily accessible without disturbing other components. Arrange for clear passage between components.

3. Set all hoistway entrances in vertical alignment with car openings and true with plumb sill lines.

4. Install machinery, guides, rails, controls, car and all equipment and accessories to provide for a quiet, smooth operation free of sideways movement, oscillation or vibration.

5. Mount machine directly over hoistway on steel beams or (mount machine adjacent to shaft with transfer pulley over opening). Isolate and dampen vibration with properly sized sound-reducing anti-vibration pads.

6. Erect hoistway sills, headers and frames prior to the erection of rough walls and doors; erect fascias and toe guards after rough walls are finished.

7. Grout sills and hoistway entrance frames.

8. Clean field welds; remove oxidation and residue. Apply touch up primer.

9. Connect equipment to building utilities.

3.03 Erection Tolerances
1. Quality Control: Tolerances.
2. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.1.
3. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.04 Field Quality Control

1. Quality Control: Field inspection, testing, adjusting, and balancing.
2. Perform tests required by ASME A17.1 and ASME A17.2.1.
3. Test elevator in presence of Owner and Architect to ensure proper operation and compliance with specified requirements; make final adjustments as appropriate.
4. Obtain inspections and permits and make such tests as are required by governing authorities. Deliver test certificates and permits to Owner.
5. Provide two weeks written notice of date and time of tests.
6. Supply instruments and execute specific tests.

3.05 Tests By Regulatory Agencies

1. QEI Certified Testing in accordance with ASME A17.1 will be performed by Owner.

3.06 Adjusting

2. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.
3. Adjust automatic floor leveling feature at each floor to achieve (+/-) 1/8 inch (3mm) from floor level.

3.07 Cleaning

2. Remove protective coverings from finished surfaces.
3. Clean surfaces and components ready for inspection.

3.08 Protection of Finished Work

2. Do not permit construction traffic within cab after cleaning.

END OF STANDARD 14265
SECTION 14270 - ELECTRIC SERVICE ELEVATORS
CONSTRUCTION STANDARD

PART 1: GENERAL

1.01 Summary

Section Includes:

1. Electric traction service elevator system.
2. Passenger cab, interior finishes, control panel and facings including cab doors.
3. Fire rated hoistway doors, sills, and frames.
5. Pit buffers.
6. Motors, variable voltage variable frequency drive, microprocessor type control system, power supply, and accessories.

1.02 Related Sections:

1. Construction Facilities and Temporary Controls: Temporary power supply.
2. Cast-in-Place Concrete: Reinforced concrete shafts.
3. Unit Masonry System: Masonry for fire rated shafts and hoistway openings.
4. Structural Steel: Structural hoist, divider, and sheave beams and other steel items.
5. Metal Fabrications: Pit ladder and accessories.
7. Panelboards: Electrical power to the machine room including main switch and breaker. Heat and smoke sensing devices.

1.03 Work Required by Other Sections:

1. The contractor shall coordinate all work required by latest applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
2. The machine room shall be enclosed and conditioned per the elevator manufacturer’s required tolerances and have temporary power available for installation work.
3. Crane service shall be provided for the hoisting of the machine room equipment.

4. All structural beams and rails shall be in place.

5. The elevator pit shall include ladder, guarded light, GFI receptacle and sump pump with cover. Light and sump pump shall each be on separate dedicated circuits.

6. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of Form C contacts, which shall change state when electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts, which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designated as the pre-transfer signal.

1.04 References

1. American Architectural Manufacturers Association (AAMA):

2. American Society of Mechanical Engineers (ASME):


   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
   h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural General Requirements.
   i. B138: Manganese Bronze Rod, Bar, and Shapes.
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l. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.

5. National Electrical Manufacturer's Association (NEMA):
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.


7. Texas Department of Licensing and Regulation (TDLR):
   a. Texas Accessibility Standards (TAS).

8. Other:
   b. AWS D1.1: Structural Welding Code.
   d. ANSI/IEEE 519: Electrical harmonic requirements.

1.05 System Description

1. Characteristics of Elevator No. (#) as follows:
   a. Type: Electric geared traction. (Select One: Top mounted machine room or Offset mounted machine room.)
   b. Control:
      1. General Supervisory:
         The supervisory control operation shall be microprocessor based and software oriented. The system shall operate in real time and continuously analyze each car's changing position, condition, and workload. The microprocessor shall continuously scan the system for hall calls. When the hall calls are registered, the control system shall instantly calculate the estimated time of arrival for each car to each assigned hall call. The following factors shall be used in calculating the estimated time of arrival; number of floors to travel from the current position, the time it takes to travel one floor at top speed, calls assigned to a car, and car reversal time to respond to a call in the opposite
direction of travel. An internal constant shall be set, requiring a maximum time for a car to respond to a call. When a car’s status changes or additional hall calls are registered, the estimated time of arrival shall be recalculated and calls reassigned if necessary.

2. Traffic Pattern:
The microprocessor shall provide flexibility to meet well-defined patterns of traffic such as up peak, down peak, and heavy interfloor demands and still adjusts for the many indeterminate variations in these patterns, which occur in buildings.

3. Load Weighing Device:
Each car shall be provided with a load weighing device which, when the particular car is filled to an adjustable percentage of the capacity load, shall cause the car to bypass the landing calls but not the car calls. These passed landing calls shall remain registered for the next following car. The device shall be unaffected by the action of compensating chain or rope. A suitable sensor shall accurately measure the weight of the car. This information shall be inputted into the elevator controller. The device shall be capable of detecting an approximate 15-pound load change under all conditions.

4. Anti-Nuisance Call Control:
The microprocessor control system shall evaluate the number of people on the car and compare that value to the number of car calls registered. If the number of car calls exceeds the number of people by a field programmable value, the car calls shall be canceled after the first call has been answered.

5. Position Selection:
The position selector shall be part of the microprocessor system. The car position in the hoistway shall be digitized through a primary position encoder. The microprocessor control system shall store the floor the position and slowdown points in memory.

6. Motion Control:
The drive control system shall be a system based primarily on car position. The velocity profile shall be calculated by the microprocessor control system producing extremely smooth and accurate stops. The velocity encoder shall permit continuous comparison of machine speed to the velocity profile and to actual car speed. This accurate position/velocity feedback shall permit a fast and accurate control of acceleration and retardation.

7. Door Standing Time Saver:
The system shall be capable of resetting the door open time upon interruption of the electronic detector prior to the expiration of the initial door open time.


b. Drive System: Variable voltage variable frequency (VVVF).

c. Rated Net Capacity: (####) lbs. (####kg).
d. Rated Speed: (###) ft/min (.##m/s).
e. Car Interior Dimensions: (#'-#") wide x (#'-#") deep.
f. Cab Height: (#'-#")
g. Cab Clear Ht. to suspended ceiling: (#'-#").
h. Hoistway and Cab Entrance Frame opening size: (#'-#") x (#'-#").
i. Door Type/Operation: Select one: center opening, single slide; center opening, two speed; single slide; single slide, two speed.
j. No. of Stops: Number (#) stops; Travel distance: (#'-#").
k. No. of Openings: Number (#); (#) at front and (#) at rear.

2. Operation (Select one):
   a. Simplex Collective.
   b. Duplex Collective.
   c. Group microprocessor controlled demand allocation.

3. Programmable controls shall allow: When car without registered car calls arrives at floor where both up and down calls are registered, initially respond to hall call in direction of travel. If no car or hall call is registered for future travel in that direction, respond to hall call in opposite direction.

4. Hall lanterns:
   a. A stainless steel vandal proof hall lantern with an audible signal shall be installed at each landing entrance for each elevator. The lanterns, when illuminated, shall indicate the elevator car, which shall stop at the landing and in which direction the car, is set to travel.

5. Door Operation and Control Features:
   a. A direct current motor driven heavy-duty operator. Operator shall be compatible with MCE Controller and adjustable without the use of proprietary tools. The system shall be designed to operate the car and hoistway doors simultaneously. Door movements shall be electrically cushioned at both limits of travel and the door operating mechanism shall be arranged for manual operation in the event of a power failure. A door protection system using microprocessor controlled infrared light beams (Janis or Microscan or equal) shall be provided. The beams shall project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen. A mechanical reopening device shall not be provided. Doors shall automatically open when the car arrives at the landing and shall automatically close after an adjustable time interval or when car is dispatched to another landing. Direct drive geared operators, A.C. controlled units with oil checks, or other deviations of these are not acceptable.

   b. If the electronic detector is activated when the doors are closing and the doors are more than one-third closed, they shall reverse direction and open only partially. The doors shall begin to reclose when the electronic detector
is deactivated. The doors shall reopen fully if the electronic detector is activated longer than a fixed time.

c. **Nudging:**
   The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If the door movement is obstructed longer than a field programmable time value, a buzzer shall sound and the doors shall close at a reduce speed.

d. The current door hold time shall be changed to a shorter field programmable time when the door protection system is activated.

e. The microprocessor control system shall provide separate timers for car call door hold open time and hall call door hold open time. The door hold open times shall be field programmable.

6. Electric limit switches shall be placed in the hoistway near the terminal landings and be designed to cut off the electric current and stop the car should it run beyond either terminal landing.

7. The elevator shall be provided with a self-leveling feature that will automatically bring the car to the floor landings. This feature shall be entirely automatic and independent of the operating device and shall correct for overtravel or undertravel. The car shall be maintained level with the landing irrespective of the load.

### 1.06 Fireman's Service

1. Provide "Firefighter's Operation" in accordance with the latest ASME A17.1.
   a. Interconnect elevator control system with building fire alarm, and smoke alarm system.
   b. Designated Landing: Egress Floor.

2. **Seismic Design:** In accordance with applicable code.

### 1.07 Independent Service

1. Provide "Independent Service Switch" in service cabinet in car. Toggle switch activation will remove that car from normal operation and cancel all pre-registered car calls and hall calls for that car.

2. Car will respond to selected floor. Car will not respond to any calls from hall call buttons. Car will only respond to calls placed on the car-operating panel. Doors will remain open at last landing requested. Doors will close with a constant pressure on "DOOR CLOSE" button.

3. Toggle switch activation to normal will return car to normal operation.

### 1.08 Emergency Operation
1. Interconnect elevator control system with building emergency electrical supply.
   
a. In the event of a normal power failure, the elevator system shall be designed to operate from the emergency electrical supply. The elevator controls shall receive an input indicating that the electrical supply is from the emergency source. The elevator controls shall then allow one unit at a time to be lowered to the egress level, open the doors, and become inactivated.
   
b. After all of the elevators have been lowered and become inactivated, one selected unit shall resume operation on the emergency electrical system. In the event that the selected unit fails, after a set time delay the next elevator in line shall assume operation.
   
c. The elevator controls shall include two inputs from the emergency electrical system. One input shall be from a set of (Form “C”) contacts, which shall change state when the electrical system has switched to emergency operation. A second input shall be from a set of normally open contacts, which shall close 0-50 seconds prior to any controlled change of the emergency electrical system and shall open after the change. This input shall be designed as the pre-transfer signal. This may not be used at the time of installation of the equipment but must be available for future use.
   
d. Once normal power is restored, the elevator controls shall return all units to normal operation.

1.09 Submittals For Review

1. Provide a signed copy of The University of Texas ENVIRONMENTAL HEALTH AND SAFETY CONSTRUCTION SITE PROCEDURES FOR CONTRACTORS, prior to commencement of any work.

2. Submit under provisions established in the project specifications, Division One requirements:
   
a. **Shop Drawings:** Include following information:
      
1. Motor, brake, drive system, valves, controller, selector, governor, and other component locations.
2. Car, machine beams, guide rails, buffers, wire ropes, counterweights and other components in hoistway.
3. Rail bracket spacing and maximum loads imposed on guide rails requiring transfer to structure.
4. Individual weight of principle components and load reactions at points of support.
5. Loads on hoisting beams.
6. Clearances and over travel.
7. Locations of components in machine room. Show arrangement so that moving elements and other equipment can be removed for repairs without disturbing other components. Arrange equipment for clear passage through doors and access doors.
8. Location in hoistway and machine room of connections for car light and telephone.
9. Locations of access doors, doors, and frames.
10. Expected heat dissipation of elevator equipment in machine room.
11. Electrical characteristics and connection requirements.

3. Samples: Illustrate cab interior finishes and car and hoistway door and frame finishes.

1.10 Submittals at Project Closeout

2. Furnish two copies of bound maintenance manuals for each elevator. Include full maintenance and operating instructions, parts list, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams.
3. Include legible schematic of all wiring diagrams of installed electrical equipment and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.
4. Provide two copies of master electric schematics and one copy of lubrication chart.
5. Tools, electrical prints, parts catalogs, keys, door keys, protective cab pads and other proprietary components shall be turned over to The University of Texas Utilities Service Elevator Inspection Department, upon final inspection of the elevator.

1.11 Quality Assurance

1. Perform Work in accordance with the latest ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section.
2. Fabricate and install door and frame assemblies in accordance with NFPA 80 and UL 10B.
3. Qualifications:
   a. Contractor:
      1. Maintain a warehouse and maintenance service in the City of Austin, Texas.
      2. Minimum (5) years, prior to bid date of this project, in the business of providing elevator service and having warehouse facilities.
      3. Maintain in Austin, Texas an adequate stock of parts for emergency and replacement purposes.
4. Qualified personnel available at Austin, Texas to insure fulfillment of maintenance and/or repair service on a 24-hour emergency call basis.

b. Installer: Employees and supervisor on payroll of elevator equipment manufacturer.

c. Equipment: Manufactured and guaranteed by the selling company; manufactured in its entirety (exclusive of cabs and doors) by the designer and manufacturer.

d. Parts, accessories, and appurtenances: Erected, installed, adjusted, tested and placed in operation by competent mechanics skilled in this work and under the direct control and supervision of the Installers experienced foreman.

1.12 Regulatory Requirements

1. Conform to the latest ASME A17.1 code for manufacture and installation of elevator system.

2. Conform to State of Texas Accessibility Standards for provisions for the disabled.

3. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

1.13 Warranty


2. Correct defective Work within a one-year period after Date of Substantial Completion.

3. Warranty: Include coverage for elevator operating equipment and devices.

1.14 Maintenance Service


2. Provide, service and maintenance of elevator system and components for Ninety Days (90) from Date of Final Acceptance of last elevator.


4. Include systematic examination, adjustment, and lubrication of elevator equipment. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.
a. Include monthly Fire Service, and emergency light Inspections and test.
b. Include Hoistway sills and Car sills.
c. Include elevator cab handrails.

5. Perform work without removing cars during peak traffic periods.

6. Maintain in Austin, Texas an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24-hour emergency call basis for this maintenance period.

7. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer.

8. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

1.15 Extra Materials


2. Supply three extra keys for each keyed switch.

3. Submit two (2) copies of bound maintenance manual for each elevator to Owner. Include full maintenance and operating instructions, parts lists, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams. Turn over to the owner for their use, all service tools and diagnostic devices required for adjusting and trouble shooting purposes. Include updates or modifications of test equipment for 10 years.

PART 2: PRODUCTS

2.01 Manufacturers

1. Contract Documents are based on (List Model #) by (List Company).

2. Equivalent products by the following are acceptable:

   a. Motion Control Engineering
   b. Thyssen/Dover
   c. KONE Inc.
   d. Tejas Elevator
   e. United Technologies Otis Elevator Company.
   f. Schindler Elevator Corp.
   g. Elevator Products Corp
   h. Innovation Industries Corp
   i. Hollister Whitney Elevator Corp.
   j. PTL Car & Hall Fixtures
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k. Owner approved equal.

3. **Substitutions:** Under provisions established in the project specifications, Division Two requirements.

2.02 Materials

1. **Steel:**
   b. Sheet: ASTM A 446, galvanized, stretcher leveled, Commercial Grade.

2. **Stainless Steel:** ASTM A 167, Type 302 or 304, No. 4 satin/brushed finish.

3. **Aluminum:** Anodizing quality.
   a. Extrusions: ASTM B 221.

4. **Plywood:** APA Structural I, Grade C-D, sanded.

5. **Plastic Laminate:** NEMA LD-3, General Purpose Type.

6. **Paints:**
   a. **Primer for steel:** Red Oxide.
   b. **Primer for wood:** Alkyd primer/sealer.
   c. **Enamel:** Semigloss alkyd.

2.03 Components

1. Shall include motors, brake, counterweight guides and guide shoes, ropes, cables, sheaves, counterweights, safety and governor, controller, controls, buttons, rails, wiring as required by NFPA 70, devices, and indicators. Component parts shall be individually specified below.

2. The machine shall be a geared traction type with motor, brake and traction drive. Sound isolation pads shall be mounted beneath the bed plates.

3. The motor shall be of a design suitable for the anticipated traffic and be rated for a high starting torque and low starting current. The motor shall be suitable for use with a variable voltage variable frequency type system and shall meet ANSI 519 requirements for electrical harmonic distortion.

4. The brake shall be spring applied and electrically released.

5. The elevator shall be provided with automatic self-leveling to a tolerance of (+/-) 1/4 inch and shall correct for travel variations and rope stretch.

6. The elevator shall have an overspeed governor and brake system.
7. **Operational Controller:**
   
a. **Motion Control Engineering Inc. (MCE) Only.** Controller shall be NEMA 1
   
b. Drive Control: (Select one): (a. PTC), (b. IMC)

8. **Landing System:** Shall be compatible with MCE controller. (Select one):
   
a. (LS-QUTE) up to 300 fpm
   
b. (LS-QUAD) over 300 fpm

2.04 Electrical System Characteristics

1. **Electrical Characteristics:**
   
a. 480 volts, three-phase, 60 Hz.
   
b. **Motor Drive Characteristics:**
      
      1. Variable voltage variable frequency system shall allow for soft start type operation.
      
      c. Refer to Division 16, - Equipment Wiring Systems: Electrical connections.

2.05 Electrical Components

1. **Boxes, Conduit, Wiring, and Devices:** Required by NFPA 70 and under provisions of Division 16.

2. **Fittings:** Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. **Spare Conductors:** Include 10 percent extra conductors and two pairs of shielded audio cables in traveling cables. Do not parallel conductors to increase electric current capacity unless individually fused.

4. Do not use armored flexible metal conduit as a grounding conductor.

5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine rooms. Provide additional components and wiring to suit machine room layout.

6. All labeling required by ASME A.17.1 shall be of permanently engraved/embossed and permanently affixed plaques. Plaques may be either plastic laminate or metallic. **“Permanent Marker” or “Labeling Tape” ID’s shall not be used.**
2.06 Machine

1. The machine shall be a single worm geared traction type with motor, brake, gearing and driving sheave mounted in the proper alignment on a steel bedplate. Sound isolation pads shall be mounted beneath the bedplates.

2. The worm shall be of hardened and ground steel, integral with the worm shaft, and shall be provided with a ball or roller thrust bearing designed to take the end thrust of the worm in both directions.

3. The ring gear shall be hobbed from a bronze rim, which shall be accurately fitted and bolted to the gear spider.

4. The sheave and gear shall be supported by heavy-duty ball or roller bearings. The roller and anti-friction metal bearings shall be provided with an adequate means of lubrication.

2.07 Motor

1. The motor shall be rated A. C., NEMA code letter “G” or as required for the torque and duty requirements. The motor shall be suitable for use with a variable voltage variable frequency type drive.

2. The motor shall be totally enclosed non-ventilated with a class F insulation rating.

3. The armature shall be dynamically balance and supported by ball bearings of adequate capacity.

2.08 Drive Control

1. The elevator drive shall be supplied a variable voltage variable frequency supply from a vector controlled pulse-width modulated alternating current motor drive.

2. The speed control shall be by means of a vector control providing independent excitation and torque current. A digital velocity encoder shall be provided on the motor giving feedback to the controller on motor speed and position.

2.09 Brake

1. The electric brake shall be spring applied. The controller shall actuate the brake and allow smooth, positive stops. The brake shall be designed for automatic application in the event of power supply failure.

2.10 Ropes
1. Provide suitable traction steel hoist ropes of size and number to insure proper wearing qualities.

2. Adequate compensation for weight of hoist ropes to be furnished when required to maintain proper counterbalance ratio.

3. Governor ropes shall be iron.

2.11 Counterweights

1. Each elevator shall be suitably counterbalanced for smooth and economical operation. Cast iron or steel plate weights shall be contained in a structural steel frame.

2. The counterweight shall be equal to the complete elevator car and approximately 40% of the specified load.

2.12 Safety and Governor

1. The car safety shall be mounted on the bottom members of the car frame and shall be operated by a centrifugal speed governor located over the hoistway. The governor shall be designed to cut off power to the motor and apply the brake whenever the governor indicates the car has excessive speed.
2.13 Lubrication

1. **Grease Fittings:** For lubricating bearings requiring periodic lubrication.

2. **Lubrication Points:** Visible and easily accessible.

2.14 Car Structural Fabrication

1. **Frame:** Fabricated steel frame of formed or structural steel shapes, gusseted and rigidly welded.

2. **Platform:** Fire retardant treated plywood subflooring assembly laid over steel stringers and ready to receive floor finish. The platform shall be completely isolated from the car sling and bracing members by vibration absorbing materials.

3. **Platform:** Aluminum checkered plate, 1/4” thick laid over steel stringers and subflooring. The platform shall be completely isolated from the car sling and bracing members by vibration absorbing materials.

4. **Sling:** Shall consist of heavy steel stiles, properly affixed to a steel crosshead and safety channels with adequate bracing members to remove all strain from the car enclosure.

2.15 Cab Fabrication

1. Based on (List Model #) manufactured by (List manufacturer).

2. **Cab Design:** Passenger Elevator:
   
   a. **Flooring:** (Rubber flooring as specified under provisions established in the project specifications, Division Nine requirements.
   b. **Sides and rear walls:** Plastic laminate.
   c. **Handrails:** Stainless steel, cylindrical profile.
   d. **Front and rear returns and transom:** Stainless steel with No. 4 finish.
   e. **Ceiling:** Translucent suspended.
   f. **Canopy:** Baked enamel on steel.
   g. **Ventilation:** 2 speed blower mounted above ceiling, with grille.
   h. **Lighting:** Fluorescent with solid lens diffuser.
   i. Provide wall hooks and removable protective mats for cab walls.
   j. Provide stainless steel license holders for display of required certificates. Design the holder to use non-visible tamper-proof fastenings. Holder shall enclose an 8 1/2” x 11” sign.

2.16 Car Operating Panel

1. Provide one/two vandal resistant flush mounted operating panel(s) containing illuminated car buttons corresponding to floors served, in car alarm button(s), and DOOR OPEN DOOR CLOSE button(s).
2. Position alarm button where it is unlikely to be accidentally actuated; not less than 35 inches above cab floor.

3. Include matching service cabinet integral with front return panel, with hinged door and lock in each car containing:
   a. Independent service switch. (Toggle Sw.)
   b. Inspection switch. (Toggle Sw.)
   c. Fan or blower switch. (Toggle Sw.)
   d. Light switch. (Toggle Sw.)
   e. Emergency stop switch. (Toggle Sw. or push pull)
   f. Locate a 110 V, 15 Amp GFI convenience receptacle in service cabinet.

4. Flush mounted Telephone:
   a. ADA compliant "hands free" type telephone.
   b. Acceptable manufacturer: Wurtec Inc. Cat. #11-582-VAN, or Owner approved equal.
   c. Engraved and filled lettering on panel; silk screened lettering not acceptable.

5. Additional operating switches for the special features specified.

6. Elevator identification number, 1/2 inch high, engraved and filled. Locate at top of panel.

7. Include an emergency light mounted above the car-operating panel.

8. DOOR HOLD OPEN PUSH BUTTON to be included. When activated by momentary pressure, the doors shall remain open for an adjustable period of time (1-180 seconds). This extended door open time will be canceled by activation of the DOOR CLOSE button. This circuit shall be rendered inoperative during Fire Service.

2.17 Car and Counterweight Guides and Guide Shoes

1. Guides for the car and counterweight shall be planed steel guide rails, properly fastened to the building structure with steel brackets.

2. Roller guides, consisting of a minimum of three tires, shall be mounted on the top and bottom of the car and counterweight frame, and shall be held in contact with the guide rail by adjustable devices. Roller guides shall run on dry, unlubricated rails.

2.18 Car Top Inspection Station
1. Provide station device to operate each elevator from on top of the car during adjustment, inspection, maintenance, and repair.

2. Operating means shall conform to the following:
   a. Device shall be of the continuous-pressure type; operate the car at a speed not exceeding 150 ft/min; operate the car subject to the electrical protective devices required by ASME A17.1 Rule 210.1d.

3. Device shall be used only for the purpose of adjustment, inspection, maintenance, and repair of the elevator or hoistway equipment.

4. Provide each elevator with an electric light protected with a guard and a convenience outlet fixture on the car top.

2.19 Cab Entrances

1. Cab Doors: Stainless steel 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction. Door shall be hung on sheave type hangers with polyurethane tires that roll on a polished track. The hanger shall be provided with adjustable eccentric rollers to take the up-thrust out of the door. The door shall be guided at bottom by non-metallic shoes sliding in the below listed threshold. Fabricate front return panels same as doors.

2. Cab Door Frames: Stainless steel; 0.058-inch (1.5mm) thick metal, standard design with smooth invisible joints.


2.20 Accessibility Provisions

1. Comply with applicable code.
   a. Locate highest button in the control panel and highest operable part of the telephone a maximum of 48 inches above floor.
   b. Provide Braille numerals immediately to left of car buttons, DOOR OPEN, DOOR CLOSE, and alarm buttons in the control panel to identify each landing or function.
   c. Provide handrails on rear of car.
   d. Sound audible signal in car when car is stopping at or passing landing.
   e. Provide landing lanterns with audible signal when car is arriving at landing; 1 for up stops and 2 for down stops.

2. Provide 2 inch high raised Braille and numerals on each landing jamb to identify landing number, characters shall be centered 60 inches above floor.
2.21 Hoistway Entrances

1. **Hoistway Doors**: Stainless steel; 0.058 inch (1.5 mm) thick metal, of insulated sandwich panel construction, flush design, rolled profiles, rigid construction.

2. **Hoistway Door Frames**: Stainless steel; 0.058-inch (1.5 mm) thick metal, of rolled profiles, standard design with smooth invisible joints.

3. **Door and Frame Construction**: 1-1/2 hour fire rating; insulated sandwich panel door construction 1-1/4 inch (32 mm) thick, minimum.

4. **Door Hangers**: Furnish and install sheave type two point suspension hangers and tracks. The sheaves shall have polyurethane tires with ball bearings properly sealed to retain grease. The hangers shall be provided with adjustable eccentric rollers to take the up-thrust of the doors. The tracks shall be drawn steel shapes, smooth surface and shaped to conform to the hanger sleeves.

5. **Sills**: “U” shaped saddles.
   a. **Material**: Extruded aluminum, except provide nickel silver at egress floor.

6. **Interlocks**: Each hoistway entrance shall be equipped with an approved type of interlock that has been tested as required by the appropriate code. The interlock shall be designed to prevent operation of the car away from the landing until the doors are locked in the closed position, and shall prevent opening the doors at any landing from the corridor side without the use of a special tool. Interlocks shall bear Underwriters’ Laboratories “B” label of approval.

7. Hoistway door-unlocking devices shall be provided on all floors and comply with ASME A17.1. These devices shall permit authorized personnel to gain access to the hoistway when the elevator car is away from the landing.

2.22 Landing Controls

1. **Landing Buttons**: Vandal-resistant stainless steel Illuminating type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows, including indications required by ASME A17.1. Hall button covers to be engraved and filled with pictograph detailing “In case of fire use stairs”. Accepted alternate “Cast Appendix H” inset to face plate as manufactured by Stencil Cutting & Supply Company.

2. **Landing Position Indicators**: Through engraved stainless steel.

3. **Car Direction Indicators**: Through engraved stainless steel.

4. **Screws**: All screws to be pin in hex tamper proof.
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2.23 Finishes

1. **Structural Metal Surfaces:** Clean surfaces of rust, oil or grease; wipe clean with solvent; prime and paint.

2. **Machine Room Components:** Clean and degrease; prime one coat, finish with one coat of enamel.

3. **Galvanized Surfaces:** Clean with neutralizing solvent; prime one coat.

4. **Aluminum:** Mill finish.

5. **Wood Surfaces not Exposed to Public View:** One coat primer; one coat enamel.

6. **Stainless Steel:** #4 Satin.

PART 3: EXECUTION

3.01 Site Inspection

1. Examine work of other Sections that affects the Elevator System. Report defects that will affect equipment or system operation to the Architect/Engineer.

2. Before fabrication, take job site measurements and verify that Work Required by Others is complete. Check measurement of space for equipment and means of access for installation and operation.

3.02 Installation

1. Install in accordance with ASME A17.1, manufacturer's instructions, and applicable codes.

2. Arrange equipment in machine room so that elements requiring removal or maintenance are readily accessible without disturbing other components. Arrange for clear passage between components.

3. Set all hoistway entrances in vertical alignment with car openings and true with plumb sill lines.

4. Install machinery, guides, rails, controls, car and all equipment and accessories to provide for a quiet, smooth operation free of sideways movement, oscillation or vibration.

5. Mount machine directly over hoistway on steel beams or (mount machine adjacent to shaft with transfer pulley over opening). Isolate and dampen vibration with properly sized sound-reducing anti-vibration pads.

6. Erect hoistway sills, headers and frames prior to the erection of rough walls and doors; erect fascias and toe guards after rough walls are finished.

7. Grout sills and hoistway entrance frames.
8. Clean field welds; remove oxidation and residue. Apply touch up primer and paint.
9. Connect equipment to building utilities.

3.03 Erection Tolerances

1. Quality Control: Tolerances.
2. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.1.
3. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.04 Field Quality Control

1. Quality Control: Field inspection, testing, adjusting, and balancing.
2. Perform tests required by ASME A17.1 and ASME A17.2.1.
3. Test elevator in presence of Owner and Architect to ensure proper operation and compliance with specified requirements; make final adjustments as appropriate.
4. Obtain inspections and permits and make such tests as are required by governing authorities. Deliver test certificates and permits to Owner.
5. Provide two weeks written notice of date and time of tests.
6. Supply instruments and execute specific tests.

3.05 Tests By Regulatory Agencies

1. QEII Certified Testing in accordance with ASME A17.1 will be performed by Owner.

3.06 Adjusting

2. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.
3. Adjust automatic floor leveling feature at each floor to achieve (+/-) 1/8 inch (3mm) from floor level.
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3.07 Cleaning

2. Remove protective coverings from finished surfaces.
3. Clean surfaces and components ready for inspection.

3.08 Protection of Finished Work

2. Do not permit construction traffic within cab after cleaning.

END OF STANDARD 14270
1.01 Escalator Preparatory Work:

1. Preparatory work is not included in the escalator contract.

2. To complete the escalator installation, the following work must be performed or furnished by contractors other than the escalator subcontractor, according to governing codes. These conditions include the following:

1.02 Work Included:

1. Section Includes:

   a. Complete furnishing and installation of electric escalators, including their associated superstructure, side balustrades and components.
   b. Escalator machinery support system, and pit enclosure.
   c. Motors, controls, wiring and connection to the main switch panel.

2. PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION:

   a. Cast-in-place Concrete: Reinforced concrete building openings
   b. Structural Steel: Placement of steel bearing plates, angles, and anchors for installation and other steel items.
   c. Metal Fabrication: Miscellaneous steel angles, brackets and accessories.
   d. Panelboards: Electrical power to machine pit including main switch and breaker.

3. Related Sections:

   a. Construction Facilities and Temporary Controls: Temporary power supply.
   b. Cast-in-Place: Framed concrete openings for escalator.
   c. Structural Steel: Structural steel floor opening framing. Structural steel bearing support.
   d. Raceways: Empty conduit to equipment devices remote from machine pit.
   e. Wiring Devices:

      1. Electrical characteristics and wiring connections.
      2. Electrical service to main disconnects in machine pit at upper end of truss for lights and drive motor including electrical power for escalator installation and testing.
3. Electrical disconnecting device to equipment prior to activation of sprinkler system.
4. Electrical service for machine pit, machine pit convenience outlet, and other electrical accessories.
5. Lighting in machine pit.

4. Work Required by Other Sections:
   a. The contractor shall coordinate all work required by applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
   b. The machine room shall be enclosed per the escalator manufacturer’s required tolerances and have temporary power available for installation work.
   c. Crane service shall be provided for the hoisting of the machine room equipment.
   d. All structural beams and rails shall be in place.
   e. The escalator pit shall include guarded light, GFI receptacle and emergency stop switch to prevent the escalator from running.

1.03 References:
1. American Architectural Manufacturers Association (AAMA):
2. American Society of Mechanical Engineers (ASME):
   b. A17.2.3: Inspector’s Manual For Escalators.
   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
i. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, General Requirements.
k. B209: Aluminum-Alloy Sheet and Plate.
l. B221: Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.

5. National Electrical Manufacturer's Association (NEMA):
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.


7. Other:
   b. AWS D1.1: Structural Welding Code.
   d. ANSI/IEEE 519: Electrical harmonic requirements.

1.04 System Description:

1. A total of (insert number) escalators shall be provided. The escalators system shall be provided as a pair. One up and one down at each level.

2. The plans, drawings and details are based on (Manufactures Name) Escalator system and components. The final details shall be coordinated with the selected and approved escalator system.

3. Characteristics of each escalator are as follows:
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a. Quantity: [Specify]
b. Unit Identification: [Specify] escalator building number
c. Floors Served: [Specify]
d. Speed: Escalator(s) shall ascend and descend at [Select one of the following]:
   1. 90 feet/minute (0.48 M/sec.)
   2. 100 feet/minute (0.51 M/sec.)
e. Vertical Rise: [Specify feet and inches]
f. Step Width: [Specify one]
   1. 24 inches (610 mm)
   2. 32 inches (810 mm)
   3. 40 inches (1016 mm)
g. Power Supply: [Specify Volts]/3 Phase/60 Hertz

1.05 Operation:

1. Operation: Constant speed under light to heavy load conditions in either direction, transit speed of handrail same as treads.

2. Switching: Key operated “On/Off” and reversing direction, control and emergency “Stop: buttons located at each end of unit.


1.06 Submittals:

1. Submit under provisions established in the project specifications, Division One requirements:
   a. Shop Drawings: Include following information:
      1. Motor, brake, drive system, controller, governor, and other component locations.
      3. Support bracket spacing; maximum loads imposed requiring load transfer to building structural framing.
      4. Individual weight of principle components and load reactions at points of support.
      5. Loads on hoisting beams.
      6. Clearances.
      7. Locations of components in machine room, arrangement so that moving elements and other equipment can be removed.
for repairs without disturbing components. Arrange equipment for clear passage through access door.

8. Location in hoistway and machine room of connections for machine and lights.

9. Locations of access doors, doors, and frames.

10. Expected heat dissipation of escalator equipment in machine room.

11. Electrical characteristics and connection requirements.

2. Product Data: Provide data on the following items:
   a. Signal and operating fixtures, operating panels, indicators.

1.07 Submittals At Project Close-out:


2. Furnish two copies of bound maintenance manuals for each escalator. Include full maintenance and operating instructions, parts list, recommended spare parts, emergency parts inventory, sources of purchases and wiring diagrams.

3. Include legible schematic of all wiring diagrams of installed electrical equipment and changes made in the work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

4. Provide two copies of master electric schematics and one copy of lubrication chart.

5. Provide one copy of master electric and one copy of lubrication chart.

1.08 Quality Assurance:

1. Perform Work in accordance with ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section.

2. Qualifications:
   a. Contractor:
      1. Maintain a warehouse and maintenance service in the City of Austin, Texas.
      2. Minimum (5) years, prior to bid date of this project, in the business of providing escalator service and having warehouse facilities.
      3. Maintain in Austin, Texas an adequate stock of parts for emergency and replacement purposes.
4. Qualified personnel available at Austin, Texas to insure fulfillment of maintenance and/or repair service on a 24-hour emergency call basis.

b. Installer: Employees and supervisor on payroll of escalator equipment manufacturer.

c. Equipment: Manufactured and guaranteed by the selling company; manufactured in its entirety by the designer and manufacturer.

d. Parts, accessories, and appurtenances: Erected, installed, adjusted, tested and placed in operation by competent mechanics skilled in this work and under the direct control and supervision of the Installers experienced foreman.

1.09 Regulatory Requirements:

1. Conform to ASME A17.1 code for manufacture and installation of escalator system.

2. Conform to State of Texas Accessibility Standards for provisions for the disabled.

3. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

1.10 Warranty:


2. Correct defective Work within a one-year period after Date of Substantial Completion.

3. Warranty: Include coverage for escalator operating equipment and devices.

1.11 Maintenance Service:


2. Provide service and maintenance of escalator system and components for Ninety- (90) Days from Date of Substantial Completion.

3. Examine system components semi-monthly. Clean, adjust, and lubricate equipment.

4. Include systematic examination, adjustment, and lubrication of escalator equipment. Repair or replace parts whenever required.
Use parts produced by the manufacturer of the original equipment.

5. Provide emergency call back service during working hours during this maintenance period.

6. Perform maintenance work using competent personnel, under the supervision and in the direct employ of the escalator manufacturer.

7. Perform work without removing escalator during peak traffic periods.

8. Maintain in Austin, Texas an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service on a 24-hour emergency call basis for this maintenance period.

9. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

1.12 Extra Materials:


2. Supply three extra keys for each keyed switch.

3. Supply hand held computer and other components necessary to test and maintain escalator and equipment. Include updates or modifications of test equipment for 10 years.

PART 2: PRODUCTS

2.01 Manufacturers:

1. Contract Documents are based on (List Model #) by (List Company).
2. Equivalent products by the following are acceptable:
   a. Dover Corporation-Elevator Division
   b. Montgomery Kone Inc.
   c. United Technologies Otis Elevator Company.
   d. Schindler Elevator Corp.
   e. Owner approved equal.

3. Substitutions: Under provisions established in the project specifications, Division Two requirements.

2.02 Materials:

1. Steel:
   b. Sheet: ASTM A 446, galvanized, stretcher leveled, Commercial Grade.

2. Stainless Steel: ASTM A 167, Type 302 or 304, No. 4 satin/brushed finish.

   a. Extrusions: ASTM B 221.

4. Plywood: APA Structural I, Grade C-D, sanded.

5. Plastic Laminate: NEMA LD-3, General Purpose Type.

6. Paints:
   a. Primer for steel: Red Oxide.
   b. Primer for wood: Alkyd primer/sealer.
   c. Enamel: Semigloss alkyd.

2.03 Components:

1. Structural Steel Components: Truss frame and end bearing plates, tracks, attachment brackets, and anchors.

2. Cast or Extruded Aluminum Components: Ribbed moving treads with ribbed risers and comb step/impact plate thresholds. Perimeter of treads shall be banded with painted yellow caution stripe (on side, front and back) per ADAG requirements.


4. Handrails: Molded neoprene, steel mesh reinforced to minimize stretch, black color.
5. **Balustrades and Skirt Panels:** Glass panels; narrow/slim profile secured to decks.

6. **Operating Equipment:** Motor and transmission drive, endless step drive chains, handrail drive, brake, safety devices, and drip pan to meet system criteria.

7. **Electrical components:** Controller, switches, conduit and conductors; UL approved.

### 2.04 Electrical System Characteristics:

1. **Electrical Characteristics:**
   a. (##) hp rated load amperes.
   b. 480 volts, three-phase, 60 Hz.
   c. (##) amperes maximum circuit breaker size.
   d. Starter Characteristics: Soft start type control.
   e. Refer to Division Sixteen, - Equipment Wiring Systems: Electrical connections.

2. **Motor:** Refer to Division Fifteen, NEMA MG1.

3. **Disconnect Switch:** Factory mount disconnect switch on equipment under provisions established in the project specifications, Division Two requirements.

### 2.05 Electrical Components:

1. **Boxes, Conduit, Wiring, and Devices:** Required by NFPA 70 and under provisions of Division 16.

2. **Fittings:** Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. **Spare Conductors:** Include 10 percent extra conductors and two pairs of shielded audio cables in traveling cables. Do not parallel conductors to increase electric current capacity unless individually fused.

4. Do not use armored flexible metal conduit as a grounding conductor.

5. Include wiring and connections to escalator devices remote from hoistway and between elevator machine rooms. Provide additional components and wiring to suit machine room layout.

### 2.06 Mechanical Equipment:
1. **Truss:** The truss shall be of a welded, hot rolled, structural steel tube construction and shall have a factor of safety as prescribed by the American Standard Safety Code for Elevators, Escalators and Dumb Waiters, A17.1. The truss shall be designed to carry the passenger capacity load and machinery components, including balustrades, as well as the weight of exterior covering of plaster or other material of equal weight. The drive machine shall be located in the upper end and a reversing station shall be located in the lower end of the truss, each provided with a machinery space and covered with removable access covers, all within the outline of the standard truss.

2. **Isolation Mounting:** The escalator supports at both upper and lower ends shall be a complete assembly of rubber and steel designed to provide isolation from the building structure.

3. **Drive Machine:** A totally enclosed geared machine specially designed for this service shall be furnished. It shall include a drive motor, electro-magnetic brake. The machine shall be mounted on the truss and be connected by direct drive to the upper step drive sprocket. A separate output shaft shall be provided for the handrail drive. The drive machine shall be designed to substantially match speeds of the step band and handrails. Lubrication of the gears and bearings shall be by synthetic based oil bath.

4. The escalator(s) shall be equipped with a motor designed for escalator service. The motor shall be of squirrel cage design, ball bearing type, integrally and horizontally mounted to the drive machine utilizing a flexible coupling. The motor shall be flange mounted to the main drive gear case and torsionally connected to the gear box input shaft by a flexible coupling. Driving motor and motor switch gear shall be designed in such a way as to provide a smooth start, which shall prevent undue strain on drive components. The motor shall be of sufficient size to operate the escalator at full-rated capacity, ascending without exceeding the rated horsepower. The motor shall be continuous rated with a temperature rise not exceeding those in the NEMA and IEE Standards. Each escalator shall be provided with a Permanent Magnet Ceramic brake, located on the high speed shaft which, when activated, shall stop the escalator in the event of a normal stop control, activation of stop button, any safety device, or upon loss of power.

5. **Permanent Magnet Ceramic Brake:** A load compensating brake system shall be installed. The brake shall be capable of automatically stopping the escalator quickly but gradually, and
shall hold the escalator stationary under full load whenever the power is interrupted. The brake shall be fail safe and electrically released. The system shall continually adjust brake torque to maintain a relatively constant deceleration independent of the load. The brake shall not cause the escalator to come to an abrupt stop. It shall be designed to meet ANSI Code deceleration requirements without adjustment. Design of the brake shall provide ease of access for inspection.

6. **Controller:** The controller shall be of the electro-magnetic type. The controller shall monitor the condition of each safety switch, brake, and motor operation, and shall cause the escalator to come to a safe stop upon activation of any safety switch, brake problem, or motor overload. Should a power failure occur, the controller shall automatically cut off the power supply to the motor, apply the brake and bring the escalator to a quick and smooth stop. The controller shall include phase and overload protection.

7. **Newel Ends:** Both the upper and lower newel ends shall be designed to allow the return of the handrail without undue stress. The upper newel end shall support the handrail around the newel through the use of an air bearing in lieu of rollers to minimize drag and maximize handrail life.

8. **Step Guidance:** A step guidance system shall be provided to control the movement of the steps both horizontally and vertically. A nominal 1/16-inch clearance shall be provided between the step and skirt panels. At the manufacturer's option, a plastic step side plate may be provided in lieu of the step guidance system.

9. **Upper Reversing Station:** The Upper Reversing Station and drive shall include a precision-machined step chain sprocket mounted on the machine output shaft and rotating on bearings.

10. **Lower Reversing Station:** The Lower Reversing Station shall consist of a floating track system designed to maintain proper tension on the step chain by use of springs. It shall be designed to maintain uniform chain tension, and shall detect movement of the carriage through the activation of a safety switch.

11. **Step Band:** The step band shall consist of consecutively running steps powered and spaced with a chain designed for long life and quiet operation. The chain shall be a precision roller flat link type, manufactured from high quality material with heat treated bushings and chain link pins.
12. **Steps:** The steps shall be formed from one-piece die cast aluminum with closely spaced tread and riser cleats. The step rollers shall rotate on sealed ball bearings. A minimum of two steps move horizontally at upper and lower landings. Vertical curved step risers shall be furnished with vertical cleats arranged to pass between the cleats of the tread on the adjacent step to form an inter-meshing unit with minimum clearances.

   a. The steps shall be designed to be easily removed from the step band on the incline without opening the unit.

   b. Step demarcation lines shall be provided on the sides and rear of each step as a safety measure. The lines shall be fabricated from reinforced structural plastic, shall be easily replaced and shall be 1-1/4 inches (32 mm) wide at the sides and 1-3/4 inches (45 mm) wide at the rear. The color of the demarcation lines shall be [Select one of the following]:

   1. Gray
   2. Red
   3. Black
   4. Yellow
13. **Comb Plates:** Adjustable comb plates shall be located at the top and bottom landings. The comb plates shall support injection molded, reinforced structural plastic comb segments, which shall be designed to be easily removable and to mesh deeply and evenly with the cleats on the step, treads. The skid resistant comb plates shall be designed to sense both horizontal and vertical movement of the comb segments.

14. **Access Covers:** Lightweight aluminum access covers shall be provided. The design of these non-skid access covers shall allow for ease of maintenance. These covers shall be provided at both upper and lower landings.

15. **Control Station:** At both the upper and lower landings, located near the handrail inlet, a station shall be provided which shall include a key actuated direction-starting switch. The controller shall prevent restarting with the key in the on position.

16. **Handrails:** Escalator handrails, properly constructed and reinforced, shall be provided. Handrails shall be endless with a smoothly vulcanized splice and shall operate with the moving steps. The handrails shall move on specially formed guides and traction sheaves. Close fitting safety guards shall be provided by handrail openings in the newel base. The handrail color shall be black.

2.07 **Safety Devices:**

1. **The following safety devices shall be provided:**

   a. **Broken Chain Safety Device:** A broken chain safety device, a part of the lower reversing station assembly, shall be provided with a safety switch for each chain designed to cut off the electrical power and bring the escalator to rest should either chain break.

   b. **Step-Up Thrust Switch:** A step-up thrust switch shall be located on each side of the lower curve track on the lower end of each escalator. This switch shall be designed to cut off the electrical power and bring the escalator to rest should a step be displaced against the up thrust track.

   c. **Comb Plate Safety Device:** A safety device shall be provided at the upper and lower landing comb plate. The sensitive electrical switches of this device shall be designed to cut off the electrical power and bring the escalator quickly to rest.
should an obstruction occur between the comb segments and step treads.

d. **Step-Skirt Safety Device:** Step-skirt safety devices shall be provided. Pressure sensitive electrical safety switches shall be located on each side of the balustrade within the skirt panels. The switches shall be designed to cut off the electrical power and bring the escalator to rest should an obstruction occur between the step and skirt panel. Switches shall be of the plunger, self-resetting type, adjustable to maintain the required position and clearance from the skirts.

e. **Missing Step Switch:** This safety feature shall be provided to prevent the unit from running if a step is missing. This shall be accomplished by an electro-mechanical device designed to detect a missing step or step(s) at the upper or lower reversing station.

f. **Step Demarcation Lights:** Step demarcation lights shall be furnished at the top and bottom of each escalator. They shall consist of a light fixture installed just below the track system where the step leaves or enters the comb plate. This fixture shall be furnished with two independent green fluorescent lamps and shall be capable of lighting the entire width of the step. The light, which shall be visible between the steps and the step and comb segment, shall provide a reference point for entering or exiting the escalator.

g. **Handrail Inlet Safety:** A handrail inlet safety device shall be provided at the handrail inlet in the newel. The sensitive electrical switch of this device shall be designed to cut off the electrical power and bring the escalator to rest should an object enter the handrail inlet area.

h. **Stopped Handrail Device:** A magnetic sensor shall be provided to sound the alarm, remove power and stop the escalator should a handrail break, stop moving, or slow beyond a preset speed.

i. **Emergency Stop Buttons:** Emergency stop buttons shall be provided, designed so that the momentary pressure of either button shall cut off the electrical power supply to the motor and bring the escalator to rest. One emergency stop button shall be located at each landing, accessible on the exterior deck cover. Location shall be in the newel upper radius quadrant, 45 degrees above horizontal, in order to provide easy access. The stop button shall be red in color.
button shall be housed under a clear, high impact resistant plastic cover, which shall be self-closing. Instructions for operating the stop button shall be imprinted on the cover in half-inch high letters. When the cover is lifted, an audible alarm shall sound until the cover is returned to its closed position.

j. Safety Signs: A pictorial sign meeting the requirements of the ANSI Code shall be provided at both the upper and lower landings. A separate sign, at both locations, shall provide escalator-riding rules.

k. Pit Stop Switch: Each escalator shall be provided with an additional safety device, in the pit that shall interrupt power within the escalator and automatically apply the brake to bring the escalator to a smooth stop.

2.08 Additional Equipment: [Select one from 1 or 2]:

1. Glass Balustrade: Glass Balustrades shall be provided between the escalator decks and the handrails. The Balustrades shall be constructed of 3/8-inch (9 mm) tempered glass and shall be installed without mullions between the panels. The color of the glass shall be [Select one of the following]:
   a. Clear
   b. Smoked
   c. Bronze

2. Balustrade: Balustrade panels shall be provided between the escalator decks and the handrails. These panels shall provide a finished surface for both the escalator interior as well as the escalator exterior above the exterior decks. Balustrade panels shall be installed without overlapping joints or requiring trim pieces to cover where two panels meet. The Balustrade shall be fabricated from hardwood plywood core wrapped in sheet metal of the type specified below:

   a. Interior Balustrade Finish: The interior of the Balustrade between the decks and handrails shall be finished in [Select one of the following]:

      1. stainless steel #4 finish
      2. stainless steel #8 finish
      3. bronze #4 finish
      4. bronze #8 finish
b. **Exterior Balustrade Finish:** The exterior of the Balustrade shall be finished in [Select one of the following]:

1. stainless steel #4 finish
2. stainless steel #8 finish
3. bronze #4 finish
4. bronze #8 finish

3. **Decks:** The escalator decks shall be constructed such that there shall be an inner deck and an outer deck. The inner decks shall be fabricated from heavy gauge metal and be installed without visible fastenings. The outer decks shall be of two-piece construction. The base construction shall be of extruded aluminum and it shall be covered with a light gauge finished material and also be installed without visible fastenings. Deck panels shall be installed without overlapping joints or requiring trim pieces to cover where two deck panels meet. Both the inner decks and outer decks shall be finished in [Select one of the following]:

a. stainless steel #4 finish
b. stainless steel #8 finish
c. bronze #4 finish
d. bronze #8 finish

e. Teflon coated

4. **Skirts:** The skirts shall be constructed from a heavy gauge material reinforced with zinc coated steel ribs. Skirts shall be fastened to the truss with hidden fastenings. Skirt panels shall be installed without overlapping joints or requiring trim pieces to cover where two skirt panels meet. The material the skirts shall be fabricated from is [Select one of the following]:

a. stainless steel #4 finish
b. stainless steel #8 finish
c. bronze #4 finish
d. bronze #8 finish
e. Teflon coated

5. **(Option) Intermediate Supports:** Escalator(s) included in this specification shall be designed with an intermediate truss support point, located to coincide with structural support provided in other sections of the specification. Structural building steel, support columns and other support structure is specified in other sections of the specification.

6. **(Option) Comb Lighting:** Lighting fixtures shall be installed at both the upper and lower ends of the specified escalator(s) to
provide additional illumination to the area of the escalator comb plates. These lights shall be mounted in the escalator skirts and be located over the intersection of the step treads and comb teeth.

7. **(Option) Apex Guards:** Where the escalator handrail center line (diagonal) intersects with a horizontal surface (e.g. ceiling, etc.), the angle of intersection shall be protected with escalator contractor supplied and installed Apex Guards. These devices shall be fabricated from Plexiglas and are designed to minimize potential pinching hazards.

8. **(Option) Anti-Slide Knobs:** Escalator units included in this specification, which are to be installed in parallel with a high outer deck, shall be equipped with anti-slide knobs. These devices shall be affixed to the escalator common deck. Material and finish of these devices shall be stainless steel.

9. **(Option) Horizontal Deck Guards:** The escalator contractor shall furnish standard, Plexiglas horizontal deck guards at the upper and lower ends of each escalator included in this specification.

2.09 **Machine:**

1. The machine shall be a single worm geared traction type with motor, brake, gearing and driving sheave mounted in the proper alignment on a steel bedplate.

2. The worm shall be of hardened and ground steel, integral with the worm shaft, and shall be provided with a ball or roller thrust bearing designed to take the end thrust of the worm in both directions.

3. The ring gear shall be hobbed from a bronze rim, which shall be accurately fitted and bolted to the gear spider.

4. The sheave and gear shall be supported by heavy-duty ball or roller bearings. The roller and anti-friction metal bearings shall be provided with an adequate means of lubrication.

2.10 **Motor:**

1. The motor shall be rated A. C., NEMA code letter “G” or as required for the torque and duty requirements.

2. The motor shall be totally enclosed non-ventilated with a class F insulation rating.

2.11 **Brake:**
1. The electric brake shall be spring applied. The controller shall actuate the break and allow smooth, positive stops. The brake shall be designed for automatic application in the event of power supply failure.

2.12 **Lubrication:**

1. **Grease Fittings:** For lubricating bearings requiring periodic lubrication.

2. **Lubrication Points:** Visible and easily accessible.

2.13 **Finishes:**

1. **Structural Metal Surfaces:** Clean surfaces of rust, oil or grease; wipe clean with solvent; prime and paint.

2. **Machine Room Components:** Clean and degrease; prime one coat, finish with one coat of enamel.

3. **Galvanized Surfaces:** Clean with neutralizing solvent; prime one coat.

4. **Aluminum:** Mill finish.

5. **Wood Surfaces not Exposed to Public View:** One coat primer; one coat enamel.

6. **Skirts:** Stainless Steel, #4 brushed finish.

7. **Decks:** Stainless steel, #4 brushed finish.

8. **Interior Panels:** Glass, clear.

**PART 3: EXECUTION**

3.01 **Site Inspection:**

1. Examine work of other Sections that affects the Escalator System. Report defects that will affect equipment or system operation to the Architect/Engineer.

2. Before fabrication, take job site measurements and verify that Work by Others is complete. Check measurement of space for equipment and means of access for installation and operation.

3. Verify that electrical power is available and of the correct characteristics.
3.02 Installation:

1. Install in accordance with ASME A17.1, manufacturer's instructions, and applicable codes.

2. Arrange equipment in machine room so that elements requiring removal or maintenance are readily accessible without disturbing other components. Arrange for clear passage between components.

3. Align components within manufacturer’s allowed tolerances to obtain operation without objectionable noise, squeaks, pulsations, jumping, vibration, or roughness.

4. Connect equipment to building utilities.

5. Field Welds: Chip and clean away oxidation and residue, wire brush and apply two coats of primer and paint.

6. Provide ready access to lubrication points.

3.03 Erection Tolerances:

1. Quality Control: Tolerances.

3.04 Field Quality Control:

1. Quality Control: Field inspection, testing, adjusting, and balancing.

2. Perform tests required by ASME A17.1 and A17.2.3.

3. Test escalator in presence of Owner and Architect to ensure proper operation and compliance with specified requirements; make final adjustments as appropriate.

4. Obtain inspections and permits and make such tests as are required by governing authorities. Deliver test certificates and permits to Owner.

5. Provide two weeks written notice of date and time of tests.

6. Supply instruments and executes specific tests.
3.05 Tests By Regulatory Agencies:
   1. QEI Certified Testing in accordance with ASME A17.1 will be performed by Owner.

3.06 Adjusting:
   2. Adjust for smooth quite operation.

3.07 Cleaning:
   2. Remove protective coverings from finished surfaces.
   3. Clean surfaces and components ready for inspection.

3.08 Protection of Finished Work:
   2. Do not permit construction traffic on escalator after cleaning.

END OF STANDARD 14280
PART 1: GENERAL

1.01 Related Sections:

1. Division 16 - Equipment Wiring Systems:
   a. Electric power for starting, testing and adjusting chair lift equipment.
   b. Fused disconnect switch or circuit breaker for chair lift per National Electric Code with feeder or branch wiring to controller.

1.02 References:


1.03 Project Record Documents:

1. Submit under provisions established in the project specifications, Division One requirements.
2. Accurately record actual locations of concealed items, conduit, and locations of components.

1.04 Operation and Maintenance Data:

1. Submit under provisions established in the project specifications, Division One requirements.
2. Include a parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
3. Provide technical information for servicing operating equipment.
4. Include legible schematic wiring diagrams of installed electrical equipment, and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.
SECTION 14400 - WHEELCHAIR LIFT
CONSTRUCTION STANDARD

1.05 Quality Assurance:


1.06 Qualifications:

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

2. Installer: Company specializing in performing the work of this section and approved by Lift equipment manufacturer.
   a. Maintain service facility locally, within 50 miles of project site.

1.07 Warranty:

1. Provide two-year warranty under provisions established in the project specifications, Division One requirements.

2. Warranty: Include coverage for Lift system, operating equipment, and devices.

1.08 Maintenance Service:

1. Furnish service and maintenance of Lift system and components for Ninety- (90) Days from date of Substantial Completion.

2. Examine monthly, clean, adjust, and lubricate all equipment.

3. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.

4. Provide emergency call back service during working hours during this maintenance period.

5. Perform maintenance work using competent personnel, under the supervision of the Lift installer.

6. Maintenance service shall not be assigned or transferred to any agent or Subcontractor.

PART 2: PRODUCTS

2.01 Manufacturers:
PART 3: EXECUTION

3.01 Adjustments:
1. Adjust work under provisions established in the project specifications, Division One requirements.
2. Adjust for smooth acceleration and deceleration of Lift.

3.02 Cleaning:
1. Project Closeout: Cleaning installed work.
2. Remove protective coverings from finished surfaces.
3. Clean surfaces and components ready for inspection.

3.03 Protection of Finished Work:
1. Project Closeout: Protecting installed work.
2. Do not permit construction traffic within Lift after cleaning.

3.04 Demonstration and Instructions:
1. Project Commissioning: Demonstrating installed work.
2. Demonstrate equipment operation in presence of Owner's representative.
3. Owner will provide QEI Inspector.

END OF STANDARD 14400
PART 1: GENERAL

1.01 Section Includes:

1. Vertical reciprocating conveyor, Hydraulic straddle VRC.
   b. Wire mesh enclosure and gates.

Related Sections

1. Division 16 - Equipment Wiring Systems:
   a. Electrical characteristics and wiring connections.
   b. Electrical service to main disconnect at machine location.
   c. Electrical service for machine.
   d. Empty conduit to lift equipment devices remote from machine.

1.02 References:

2. ASTM A36 - Structural Steel.
3. ASTM A 325 - High Strength Bolts for Structural Steel Joints.
4. AWS D1.1 - Structural Welding Code.

1.03 System Description:

1. Characteristics of Materials Lift as follows:
   a. Type: Hydraulic Straddle Lift.
   b. Capacity: 3500 lbs.
   c. Lift height: 14'-5".
   d. Landings: Two; Third floor (Track Level) and Fourth floor (Catwalk Level).
   e. Speed: 20 fpm.
   f. Platform size: 7'-0"between masts x5'-9"parallel to masts.
   g. Loading/unloading pattern: "C".
   h. Enclosure and Gates: Wire mesh.
k. **Operation:** Electric traction machine with counterweights.
l. **Controls:** Self-maintained, 3-button momentary contact.
m. **Accessories:** Approach ramp.

1.04 **Operation:**

1. **Raising and lowering of Carriage:** Provide through push button remote control station at each landing which control two cylinders mounted on unit; transmission of lifting force through wire rope attached to cylinders and Carriage in a manner that produces a 4:1 ratio of Carriage movement to cylinder stroke.

2. **Upward travel of Carriage:** Provide positive mechanical stops to assure positive leveling with upper level.

3. **Uncontrolled Decent:** Protect against with dual safetycams attached to lifting cables.

4. **Redundant Overload:** Provide to prevent raising of Carriage if loaded more than 105% of rated capacity.

5. **Interlocks:** Electrically interlock gates to prevent a gate from being opened unless Carriage is at that level and to prevent Carriage movement if one of gates is not fully closed.

1.05 **Submittals:**

1. Submit under provisions established in the project specifications, Division One requirements.

2. **Shop Drawings:** Indicate the following information:

   a. Driving machine, controller, selector, governor and other component locations.

   b. Include elevations, dimensions, materials, finishes, accessories, and attachment to adjacent construction.

3. **Product Data:**

   a. Manufacturer's specifications, rough-in diagrams, and installation instructions.

   b. Electrical characteristics and connection requirements.

1.06 **Project Record Documents:**

1. Submit under provisions established in the project specifications, Division One requirements.
2. Accurately record actual locations of concealed items, conduit, and locations of components.

1.07 Operation and Maintenance Data:
1. Submit under provisions established in the project specifications, Division One requirements.
2. Include a parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
3. Provide technical information for servicing operating equipment.
4. Include legible schematic wiring diagrams of installed electrical equipment, and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.
5. Provide one copy of master schematic and one copy of lubrication chart, framed, with clear plastic; mount on machine room wall.

1.08 Quality Assurance:
1. Perform Work in accordance with ASME B20.1, AWS D1.1, and IEEE C1.

1.09 Qualifications:
1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.
2. Installer: Company specializing in performing the work of this section and approved by lift equipment manufacturer.
   a. Maintain service facility locally, within 50 miles of project site.

1.10 Field Measurements:
1. Verify that field measurements are as indicated on shop drawings.

1.11 Warranty:
1. Provide two-year warranty under provisions established in the project specifications, Division One requirements.
SECTION 14500 - MATERIALS LIFT
CONSTRUCTION STANDARD

2. Warranty: Include coverage for straddle lift system, operating equipment, and devices.

1.12 Maintenance Service:

1. Furnish service and maintenance of Straddle Lift system and components for Ninety- (90) Days from date of Substantial Completion.

2. Examine monthly, clean, adjust, and lubricate all equipment.

3. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.

4. Provide emergency call back service during working hours during this maintenance period.

5. Perform maintenance work using competent personnel, under the supervision of the Straddle Lift installer.

6. Maintenance service shall not be assigned or transferred to any agent or Subcontractor.

PART 2: PRODUCTS

2.01 Manufacturers:

1. Wildeck, Inc. P.O. Box 89, Waukesha, WI. 53187; 800/325-6939.

2. Substitutions: Under provisions of Section 01600.

2.02 Materials:


2.03 Equipment:


2. Guide Rails, Wire Ropes, Counterweights, Sheaves, Attachment Brackets and Anchors: Purpose designed, sized according to code with safety factors.

2.04 Electrical Characteristics and Components:
1. Electrical Characteristics:
   a. Motor: 5 HP.
   b. 6.7 AMP.; 10 AMP. full load.

2. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Division 16.

2.05 Electrical Components:


2. Fittings: Steel compression type for electrical metallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. Do not use armored flexible metal conduit as a grounding conductor.

4. Provide additional components and wiring to suit machine layout.

5. Electrical Control:
   a. Control station at each Level: 24 volt; push button station marked "UP," "DOWN," AND "EMERGENCY STOP".

2.06 Lubrication:

1. Grease Fittings: For lubricating bearings requiring periodic lubrication.

2. Grease Cups: Automatic feed type.


2.07 Carriage Fabrication:

1. Frame: Rigid rolled steel sections, braced.

2. Flooring: Min. 1/4" thick steel checkered plate.

3. Railings for non-operating sides:
   a. Fabricate from 1-1/2"dia. round steel pipe. Make bends uniform and free from buckles or other defects.
   b. Miter and cope intersections within 2 degrees, fit to within 1/8 inch and weld all around.
c. Weld connections.

4. Provide chains on operating side.

2.08 Enclosure and Gate Construction:

1. Height: 8'-0"; provide at each landing.

2. Wire: Steel wire woven into diamond mesh of gauge and size which will reject a ball 3/4" diameter, securely clinched to frames and gates.

3. Frames:
   a. Vertical frames: 1-1/4" x 5/8" cold rolled "C" section channels with 1/4" bolt holes at 12"o.c.
   b. Horizontal frames: 1" x 1/2" cold rolled channels, with joints mortised and tenoned.

4. Hinged gate frames: 1-1/4" x 1/2" channel with 1-1/4" x 1/8" flat bar cover three sides, 1-3/8" x 3/4" x 1/8" angle riveted to lock side. Provide 1-1/2" pairs butt hinges riveted to both gate and frame.

2.09 Finishes And Signs:

1. Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime one coat of Manufacturer's standard high solids industrial enamel.

2. Signs: At each point of operation and access, provide signage to read "RIDING THE CONVEYER IS FORBIDDEN".

PART 3: EXECUTION

3.01 Installation:

1. Install system and components in accordance with ASME B20.1.

2. Arrange equipment in room so equipment can be removed for repairs or replaced without dismantling or removing other equipment components.

3. Connect equipment to building utilities.

4. Provide conduit, boxes, wiring and accessories within machine room, hoistway and signal outlets.
5. Field Welds: Chip and clean away oxidation and residue, wire brush and apply two coats of primer.

3.02 Adjustments:

1. Adjust work under provisions established in the project specifications, Division Three requirements.

2. Adjust for smooth acceleration and deceleration of Lift.

3. Adjust feature at each landing.

3.03 Cleaning:

A. Project Closeout: Cleaning installed work.

B. Remove protective coverings from finished surfaces.

C. Clean surfaces and components ready for inspection.

3.04 Protection of Finished Work:

1. Project Closeout: Protecting installed work.

2. Do not permit construction traffic within lift after cleaning.

3.05 Demonstration and Instructions:

1. Project Commissioning: Demonstrating installed work.

2. Demonstrate equipment operation in presence of Owner's representative.

END OF STANDARD 14500
PART 1: GENERAL

1.01 Summary

Section Includes:

1. Electric traction Dumbwaiter system.
2. Cab, interior finishes, control panel and facings including cab doors.
3. Fire rated hoistway doors, sills, and frames.
5. Pit buffers.
6. Motors, variable voltage variable frequency drive, microprocessor type control system, power supply, and accessories.

Related Sections:

1. Construction Facilities and Temporary Controls: Temporary power supply.
2. Cast-in-Place Concrete: Reinforced concrete shafts.
3. Unit Masonry System: Masonry for fire rated shafts and hoistway openings.
4. Structural Steel: Structural hoist, divider, and sheave beams and other steel items.
5. Metal Fabrications: Pit ladder and accessories.
7. Panelboards: Electrical power to the machine room including main switch and breaker. Heat and smoke sensing devices.

Work Required by Other Sections:

1. The contractor shall coordinate all work required by applicable codes including fire and smoke rated hoistway enclosures, pits, shaft venting, operable fire alarm systems, etc.
2. The machine room shall be enclosed and conditioned per the elevator manufacturer’s required tolerances and have temporary power available for installation work.

3. Crane service shall be provided for the hoisting of the machine room equipment.

4. All structural beams and rails shall be in place.

5. The dumbwaiter pit shall include, guarded light, GFI receptacle and emergency stop switch to prevent the elevator from descending.

1.02 References:

1. American Architectural Manufacturers Association (AAMA):

2. American Society of Mechanical Engineers (ASME):


   a. A36: Structural Steel.
   c. A325: High Strength Bolts for Structural Steel Joints.
   d. A446: Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
   e. A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
   h. A501: Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   i. A525: Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, General Requirements.
   k. B209: Aluminum-Alloy Sheet and Plate.

m. C1048: Heat Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.

5. National Electrical Manufacturer's Association (NEMA):
   a. FS L-P-508: Plastic Sheet, Laminated, Decorative, and Nondecorative.
   b. LD-3: High Pressure Decorative Laminates.
   c. MG1: Motors and Generators.
   d. PS-1: Construction and Industrial Plywood.


7. Other:
   b. AWS D1.1: Structural Welding Code.
   d. ANSI/IEEE 519: Electrical harmonic requirements.

1.03 System Description:

1. Characteristics of Dumbwaiter as follows:
   a. Type: Electric Dumbwaiter.
   b. Capacity: ______ lbs.
   c. Nominal travel distance: _____ ft, _____ in.
   d. Number of stops: ________.
   e. Number of openings: ______ front, ______ rear.
   f. Speed: _____ fpm.
   g. Car size: ______ wide X ______ deep X ______ high.
   h. Hoistway and Cab Entrance Frame opening size: 24 X 36 in. (nominal).
   i. Door Type: Center opening vertical bi-parting. (Manual), (Power).
   j. Machine Location: ____________________________.
   k. Operation: (Electric traction machine with counterweights), (Drum Machine).
   l. Controls: Self-maintained, 3-button momentary contact.
   m. Accessories: Approach ramp.

1.04 Operation:
1. Provide single automatic call and send operation with full bank of operating buttons at each landing numbered to correspond to landing.

2. Call or dispatch car to various landings by momentary pressure of respective buttons when landing doors are closed.

3. Indicate arrival of car at landings by light and audible bell at landing.

4. Inactivate buttons while car is in motion and for several seconds after arrival at landing to allow time to open door.

5. Interlocks: Electrically interlock gates to prevent a gate from being opened unless dumbwaiter is at that level and to prevent dumbwaiter movement if one of gates is not fully closed.

6. Program doors to open automatically when car arrives at the counter landing and level to the opening.

7. If doors are prevented from closing for approximately ten seconds because of an obstruction, automatically disconnect door control device, and sound alarm.

1.05 Call and Send Operation:

1. Initiate call with momentary pressure on buttons at each landing labeled to bring car to that labeled landing. Provide lighted and numbered landing level buttons for floors served at each landing.

2. Dispatch car to desired landing by momentary pressure on button of the floor level desired when the doors are closed.

3. Include a two-bank light identifying the following condition-”Car Here” and “In Use”.

1.06 Submittals:

1. Submit under provisions established in the project specifications, Division One requirements.

2. Shop Drawings - Indicate the following information:

   a. Driving machine, controller, selector, governor and other component locations.

   b. Car, sheaves, machine and sheave beams, guide rails, buffer, ropes, and other components in hoistway.

   c. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
d. Individual weight of principal components; load reaction at points of support.
e. Loads on beams and supports.
f. Clearances and over travel of car.
g. Locations in hoistway and machine room of traveling cables.
h. Location and size of access doors and frames.
i. Expected heat dissipation of equipment in machine room.
j. Electrical characteristics and connection requirements.
k. Show arrangement of equipment in machine room so rotating elements, sheaves, and other equipment can be removed for repairs or replaced without disturbing other components. Arrange equipment for clear passage through access door.

3. Product Data:

   a. Signal and operating fixtures, operating panels, indicators.
   b. Cab design, dimensions, layout, and components.
   c. Cab and hoistway door and frame details.
   d. Electrical characteristics and connection requirements.

1.07 Project Record Documents:

1. Submit under provisions established in the project specifications, Division One requirements.

2. Accurately record actual locations of concealed items, conduit, and locations of components.

1.08 Operation and Maintenance Data:

1. Submit under provisions established in the project specifications, Division One requirements.

2. Include a parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.

3. Provide technical information for servicing operating equipment.

4. Include legible schematic wiring diagrams of installed electrical equipment, and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

5. Provide two copies of master schematic and one copy of lubrication chart, To Owner.

1.09 Quality Assurance:
1. Perform Work in accordance with ASME A17.1, ASME B20.1, AWS D1.1, and IEEE C1.

1.10 Qualifications:

1. **Manufacturer:** Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

2. **Installer:** Company specializing in performing the work of this section and approved by lift equipment manufacturer.
   a. Maintain service facility locally, within 50 miles of project site.

1.11 Field Measurements:

1. Verify that field measurements are as indicated on shop drawings.

1.12 Warranty:

1. Provide one-year warranty under provisions established in the project specifications, Division One requirements.

2. **Warranty:** Include coverage for dumbwaiter system, operating equipment, and devices. The dumbwaiter manufacturer and installer shall guaranty the materials and workmanship of the system provided under these specifications and will repair or replace any defects which may develop.

1.13 Maintenance Service:

1. Furnish service and maintenance of dumbwaiter system and components for Ninety- (90) Days from date of Substantial Completion.

2. Examine monthly, clean, adjust, and lubricate all equipment.

3. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.

4. Provide emergency call back service during working hours during this maintenance period.

5. Perform maintenance work using competent personnel, under the supervision of the Straddle Lift installer.
SECTION 14600 - DUMBWAITERS
CONSTRUCTION STANDARD

6. Maintenance service shall not be assigned or transferred to any agent or Subcontractor.

PART 2: PRODUCTS

2.01 Manufacturers:

1. D A Matot, St. Paul, Minnesota, “Ambassador DM Model-Series 100”.
2. Substitutions: Under provisions of Section 01600.

2.02 Materials:

2. Sheet Steel: ASTM A446 Grade B, zink coated to G90.
3. Stainless Steel: ASTM A167 Type, 304, No. 4 brushed finish.
5. Shop and Touch-up Primer: Red Oxide. (NO LEAD)

2.03 Equipment:

1. Motor, Controller, Controls, Buttons, Wiring and Devices, Indicators: Required by NFPA 70.
2. Guide Rails, Wire Ropes, Counterweights, Sheaves, Attachment Brackets and Anchors: Purpose designed, sized according to code with safety factors.
3. Guide rails shall be the manufacturer’s standard “Tee” shape, secured to the floor slab, upper floor/ceiling slab and hoistway walls with steel brackets. Coordinate with the structural concrete framing. Guide shoes shall be adjustable with replaceable gibs.
4. Machine: Winding drum type; single speed motor; high starting torque and low starting capacity circuitry; machine shall be located at the bottom of the hoistway with a door in the hoistway for access, with cylinder keyable to the building’s master key system.
5. Brakes: Manufacturer’s standard type with spring-applied and electrically-released type.
6. **Controller:** UL listed; wall mounted type with lockable door, recessed into the wall adjacent to the hoistway; controller must be in sight of the access door.

7. **Hoistway Ropes:** As required by manufacturer; Shall comply with ASME A17.1.

2.04 **Electrical Characteristics and Components:**

1. **Electrical Characteristics:**
   a. Motor: ____ HP.
   b. ____ AMP; ____ AMP. full load.
   d. 80+ percent minimum power factor at rated load.

2. **Motors:** NEMA MG1.

3. **Disconnect Switch:** Factory mount disconnect switch on equipment under provisions of Division 16.

2.05 **Electrical Components:**

1. **Boxes, Conduit, Wiring, and Devices:** Required by NFPA 70.

2. **Fittings:** Steel compression type for electricalmetallic tubing. Fittings with set screws are acceptable only when a separate grounding conductor is also installed across the joint.

3. Do not use armored flexible metal conduit as a grounding conductor.

4. Provide additional components and wiring to suit machine layout.

2.06 **Lubrication:**

1. **Grease Fittings:** For lubricating bearings requiring periodic lubrication.

2. **Lubrication Points:** Visible and easily accessible.

2.07 **Car Fabrication:**

1. **Walls and Ceiling:** 16 gauge stainless steel.

2. **Flooring:** Stainless steel. Provide one removable shelf unit.

3. **Car Gates/Doors:** 16 gage thick stainless steel, flush design, rigid construction, welded corner design, smooth joints; vertical bi-parting to
match the hoistway doors. Hoistway and car doors shall open simultaneously.


2.08 Hoistway Landing Entrances:

1. Landing Doors:

2. Landing Door Frames: 16 Guage thick stainless steel; welded single unit design with smooth joints and welded corners.

3. Door and Frame Construction: UL 10B 2 hour B-label fire rated, with applicable 1 1/2 hour fire rating; insulated sandwich panel construction.

2.09 Machine Access Entrances

1. Machine Access Door and Frames: Size, 24 X 24 inches; 16 gauge; self-closing and locking, of the same construction as landing doors and frames.

2. Door and Frame Construction: UL 10B 2 hour B-label fire rated, with applicable 1 1/2 hour fire rating; insulated sandwich panel construction.

2.09 Finishes And Signs:

1. Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime one coat of Manufacturer's standard high solids industrial enamel.

2. Machine Room Components: Clean and degrease; prime and paint one coat.

3. Galvanized Surfaces: Clean with neutralizing solvent; prime one coat.

4. Enamel on steel: Clean and degrease metal surface; apply one coat of primer, two coats of enamel; sprayed and baked; color as selected.

2.10 Operational Controls:

1. Control Panel: Stainless steel face plates with brushed finish, mounted on the doorframe or adjacent to the door.

2. Landing Call/Send Buttons: Clear illuminating type acrylic actuators with raised landing identification (numerals).
3. **Signal Devices:** Door open call buzzer to sound when the hoistway or car door is open and actuator is pushed; Chime and light indicating car arrival; Combination Door Open and In-Use light will illuminate when car is in transit and when a pushbutton (actuator) is pressed and a hoistway door or car gate is open.

4. Mount landing controls at ADA accessible height, 48 inches AFF for the highest actuator. All buttons, actuators, or other devices shall have raised Braille identifying labeling per the Elevator Code ASME A17.3 and ASME A17.1.

**PART 3: EXECUTION**

3.01 **Examination:**

1. Verify site conditions under provisions of section 01005.

2. Verify that hoistway, and machine areas are of correct dimension.

3. Verify location and layout of hoistway, guides, and position of machine.

4. Verify that electrical power is available and have correct characteristics.

3.02 **Preparation:**

1. Arrange for temporary electrical power for installation work and testing of dumbwaiter components.

3.03 **Installation:**

1. Install system and components in accordance with ASME A17.1, ASME B20.1

   a. Bolt machine directly to structural concrete slab.

2. Arrange equipment in room so equipment can be removed for repairs or replaced without dismantling or removing other equipment components.

3. Connect equipment to building utilities.

4. Provide conduit, boxes, wiring and accessories within room, hoistway and signal outlets.

5. **Field Welds:** Chip and clean away oxidation and residue, wire brush and apply two coats of primer and paint.
3.04 Adjustments:
   1. Adjust work under provisions established in the project specifications, Division Three requirements.
   2. Adjust for smooth acceleration and deceleration of Lift.
   3. Adjust feature at each landing.

3.05 Cleaning:
   1. **Project Closeout:** Cleaning installed work.
   2. Remove protective coverings from finished surfaces.
   3. Clean surfaces and components ready for inspection.

3.06 Protection of Finished Work:
   1. **Project Closeout:** Protecting installed work.
   2. Do not permit construction traffic within lift after cleaning.

3.07 Demonstration and Instructions:
   1. **Project Commissioning:** Demonstrating installed work.
   2. Demonstrate equipment operation in presence of Owner's representative.

END OF STANDARD 14600
PART 1 GENERAL

1.01 Scope of Standard:

A. The design guidelines contained herein include the requirements for systems, materials, fittings and valves utilized for fire protection systems at The University of Texas at Austin. It is the intention of this document to provide a minimum standard for fire protection materials, fittings, and valves at the University so as to provide the highest level of fire safety possible. This document is not intended to be a guide specification.

1.02 Scope of Work

A. Reference Standards (Utilize latest editions available):
   2. NFPA 14- Standard for the Installation of Standpipe and Hose Systems.
   5. NFPA 20-Standard for the Installation for Fire Pumps
   6. NFPA 72-National Fire Alarm and Signaling Code

B. Provide all design, materials and installation required to provide a complete fire protection system to protect the specified building in accordance with design requirements. The preference of the University is to connect to the campus Fire Water Distribution System (FWDS) provide code compliant combination wet automatic fire sprinkler and, where possible, automatic standpipe systems, that do not contain alarm valves and without requiring a building fire pump.

C. A minimum 10-psi or 10% safety factor, whichever is greater, shall be provided.

D. Provide a complete automatic sprinkler system as defined by the latest edition of NFPA 13. All fire sprinkler systems installed on campus are required to be wet pipe systems unless the area being protected cannot be maintained above 40 degrees F, as required per NFPA 13. These areas will require a dry pipe system to be installed. Antifreeze systems of any size are not permitted on campus. Rooms or areas where it is not desirable to have water filled piping within the room, such as special collections, computer rooms, etc. may utilize double interlock preaction systems. Use of preaction systems must be approved by the University prior to system design.

1.03 Related Work: References/Quality Assurance:

A. The University of Texas, International Building Code, National Fire Codes as published by the National Fire Protection Association (NFPA), State Fire Marshal, and The University of Texas Fire Marshal’s requirements contain fire protection criteria and requirements for the installation of all fire suppression systems. The contractor shall conform to the following:
1. All materials and performance shall meet the appropriate ANSI, ASME and ASTM Codes.
2. Welding Materials and Procedures shall conform to the ASME Code.
3. Only welders certified in accordance with ANSI/ASME Section 9 shall be employed.

B. Each item of equipment shall be new and listed by Underwriters Laboratories (UL) or approved by FM Global. Each major item of equipment shall bear the manufacturer’s name or trademark; serial number, and/or UL/FM label.

1.04 Submittals

A. The University of Texas Project Manager shall review and distribute all submittals for approval by the University insurer, the UT Fire Marshal, UT FSSS, the Owner’s representative, and others as appropriate.

B. Refer to provisions established in the Project Specifications and in related section of Division 01 – General Requirements. All product data shall be submitted under provisions of Division 01.

C. Manufacturer’s data sheets shall be provided for all materials and equipment for approval before purchase or installation. Data sheets shall describe the type of material, capacities, manufacturer, part numbers of equipment, and give information necessary for verifying equipment approval.

D. The Contractor shall submit detailed and accurate shop drawings prepared in accordance with NFPA 13, NFPA 14, NFPA 20, and NFPA 24 for approval of all equipment to be constructed and installed. Shop drawings shall identify all materials and list all equipment to be used. Shop drawings shall include ceiling grid or reflected ceiling layout and shall be coordinated with other trades prior to submittal. Shop drawings are to be submitted with a minimum 1/8” scale and all details at a minimum ¼” scale.

E. Hydraulic calculations for standpipe systems shall comply with NFPA 13 and shall include comprehensive hydraulic data sheets. Provide a 10 psi or 10% safety factor, whichever is greater, for all standpipe system hydraulic calculations.

F. Provide hydraulic calculations for automatic standpipes, where required per NFPA 14, to provide 100 psi when flowing 500 gpm at the most remote standpipe outlet and 250 gpm at each additional standpipe. Provide hydraulic calculations for manual standpipes to demonstrate the pressure available at the top of each standpipe while flowing the demand required per NFPA 14 utilizing both the available water supply and the nominal City of Austin fire truck pumper through the fire department connection.

G. Prior to preparing shop drawings and hydraulic calculations, the design engineer is required to verify the adequacy of the water pressure and other pertinent water supply data from either the campus Fire Water Distribution System (FWDS) or the City of
Austin water distribution system, depending on which system will be utilized to supply the new sprinkler and/or standpipe system. Hydrant flow tests performed on the University distribution system shall incorporate erosion control requirements identified in this standard. See 2.10L Field Acceptance. The design engineer shall immediately notify the UT Fire Marshal and Project Manager of the need for testing the appropriate water supply or fire pump, or the need for any special considerations required. The engineer shall provide the record data at the point of the new utility connection as follows:
1. Building Name and flange elevation (ft)
2. Test hydrants (hydrant numbers and location) and hydrant elevations (ft)
3. Flow rate (gpm), static pressure (psi), and residual pressure (psi)
4. All turning of valves and operation of fire pump to be performed by FSSS. Actual test to be performed by Contractor or Engineer utilizing their own equipment.
5. If flowing water on campus, the Project Manager shall submit a request for approval to EH&S.

H. No work shall be performed until the University has approved the shop drawings, calculations, and data sheets. The contractor is solely liable for any work performed prior to this approval.
1. The University of Texas Project Manager shall review and distribute all submittals including drawings, calculations, and material data for approval by the University of Texas, the UT Fire Marshal, the Owner representative, and others as appropriate. For Fire Sprinkler Equipment descriptors, reference Fire Alarm Standard 5.28.30.

PART 2 PRODUCTS

2.01 Pipe:

A. Aboveground Pipe
1. All wet sprinkler system piping shall be a minimum of schedule 40 black steel with threaded fittings for 1 inch piping, and black schedule 40 steel with grooved fittings for sizes 1 ¼ inch pipe and larger. All dry and preaction system piping and fittings are required to be externally and internally galvanized.
2. CPVC piping listed for use in fire sprinkler systems may be utilized where installed in accordance with the UL listing. CPVC piping may only be installed in residential and light hazard occupancies when the piping is installed and protected in accordance with the manufacturer’s listed requirements. Provide CPVC fittings that are listed with the CPVC piping being utilized. CPVC piping and fittings must be compatible with MIC injection chemicals.
3. Piping shall be concealed above suspended ceilings where installed, in a craftsman like manner, and shall not interfere in the complete function of other systems such as cable trays, access panels, or pedestrian passageways. Piping in all occupied areas and mechanical area passageways shall not be lower then 7’-6”. Specific written approval may be granted for unavoidable projections, but under no circumstance shall overhead piping be installed lower then 6’-8” above the floor. Piping shall not reduce the required width of any means of
egress, width of stairs, or clear width of a corridor or passageway, to less than
44 inches in width. Installation of all piping shall be in coordination with piping, ducts, light fixtures, and any other work that may obstruct sprinklers. The contractor shall coordinate with all trades having materials installed above the ceiling prior to commencement of any work.

4. Piping that is retrofit into an existing building with suspended ceilings shall be installed above the existing ceiling, unless exposed piping is approved by the University.

5. All exposed sprinkler and standpipe system pipe located in areas without suspended ceilings is required to be painted. Prepare galvanized pipe as necessary, such as priming, prior to painting pipe. Coordinate color of pipe with the University.

6. All concealed pipe and exposed pipe that is not painted red is required to be marked “Fire Protection”. Pipe Markers must be wrap around type with white letters at a minimum of 1 inch in height. All pipe markers must be visible from the floor. Spacing and location as follows:
   a. Above Ceiling Corridors: Every 20’ for mains. One (1) on each branch line.
   b. Above Rooms with Ceilings: One (1) in every room on each branch line. Every 20’ for mains (at least one (1) in each room).
   c. Exposed Areas Non-painted Pipe: Every 20’ for mains and branch lines (at least one (1) on each branch line) and in each room.
   d. Exposed Areas Painted Pipe: Pipe markers not required (as long as pipe is painted red – any other color to follow above.

B. Underground Pipe:
   1. Each underground pipe joint or connection shall include a compression-type joint restraint device (Mega Lug or equal). Any changes in direction of underground piping shall be provided with a thrust block or joint restraint as required per NFPA 13 and NFPA 24. Changes in direction where entering buildings shall be provided with both thrust blocks and joint restraint.
   2. Underground pipe shall be installed by either a fire sprinkler contractor or an underground contractor licensed by the State of Texas to install underground fire service mains.
   3. All underground pipe connecting sprinkler and standpipe systems to the campus Fire Water Distribution System (FWDS) shall be rated for the maximum churn, or no flow pressure, of the largest fire pump in the FWDS zone plus the maximum static pressure at the suction side of the FWDS fire pump. Pipe shall be hydrostatically tested at the highest static pressure rating plus 50 psi, or 200 psi, whichever is greater per NFPA 24.
   4. No underground pipe shall be covered until a joint inspection by Fire Prevention Services and/or Fire Safety Shop.

SEE JOCKEY PUMP DETAIL IN SECTION 5.21.40

2.02 Mechanical Grooved Couplings

A. When grooved couplings are used, rolled-grooved joints are required with fittings and couplings designed for a working pressure of 300 psi. Malleable iron housing clamps:
ASTM A47; UL labeled; engage and lock, designed to permit some angular deflection, contraction, and expansion (Firelock fittings acceptable).

B. Galvanized couplings are required for galvanized pipe.


D. Steel bolts, nuts and washers: ASTM A183 heat treated with a minimum tensile strength of 110,000 psi.

E. Victaulic grooved couplings Style 009 are not permitted for use on the campus.

2.03 Valves

A. Unless specified otherwise, all valves shall be UL listed and/or FM approved and be suitable for the maximum anticipated system pressure or a minimum of 175 psi working pressure, whichever is greater.

B. All valves in the sprinkler system shall be UL listed and/or FM approved butterfly type indicating valves except for the following, which shall be O.S. & Y:
   1. All indicating valves on the suction side of a fire pump.
   2. Where indicated on the contract drawings.

C. All butterfly valves shall have a built in tamper resistant switch for supervision of the open position. The switch shall be contained within a NEMA Type 1, general purpose indoor rated housing. Either unauthorized removal of the switch housing (when the valve is open) or closing the valve, shall cause the switch contacts to change position. The switch shall have four conductors to accommodate connections to Style 4 or Style 6 signaling line circuit devices.
   1. Victaulic butterfly valves acceptable if manufactured in the year 2010 or later.
   2. Tyco TFP-101 Trim valves and TFP-202 Test Drain valves are not permitted to be used on campus.

D. Where OS&Y indicating valves are installed, the following shall apply:
   1. Valves 2-1/2 inches and larger shall be iron body with brass seats, discs, and stems. Include tamper switches listed for use with OS&Y valves.
   2. Valves 2 inches and smaller shall be brass body, stem, and seat. Include tamper switches listed for use with OS&Y valves.

E. Check valves shall comply with the following:
   1. Check valves 2-1/2 inches and larger shall be iron body swing check with cast brass hinge, rod, and brass faced discs.
   2. Check valves 2 inches and smaller shall be UL listed brass body and all brass fitted.

F. Ball valves shall be constructed of forged brass with Teflon seats and shall be provided with a vinyl-covered handle.
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DESIGN AND CONSTRUCTION STANDARD

G. Post Indicator Valve
   1. Gate valve on incoming water service shall be operable by a UL listed post
      indicator valve with tamper switch monitored by the associated building fire
      alarm panel.

H. All valves controlling water supply for sprinklers shall be readily accessible for use
   by emergency and maintenance personnel.

I. Except for underground water supply valves located in roadway boxes, all valves
   controlling water supply to sprinklers shall be supervised by the fire alarm system.

J. A control valve shall be installed at the base of each riser. (Put into Section:
   Standpipe: 5.21.10; Locate standpipe isolation control valves within the stair
   enclosure and exposed for maintenance purposes.)

K. Pressure reducing valve:
   1. Sprinkler systems connected to the campus FWDS or new fire pump system are
      required to be provided with a pressure reducing valve. The discharge pressure
      setting of the pressure reducing valve shall not exceed 155 psi.
   2. All pressure reducing valves are required to be installed per UT Detail Drawing
      FWDS-01 Rev 4.

SEE JOCKEY PUMP/PRV DETAIL IN SECTION 5.21.40

2.04 Piping Accessories:

A. All hanger components other than all thread shall be UL listed and/or FM approved.
   No sprinkler piping is to be supported from any mechanical or electrical devices
   and/or equipment (ducts, lights, etc.). Hanger assemblies installed outside, or
   otherwise exposed to weather, shall be externally galvanized.

B. Provide sleeves where pipes penetrate beams, floors, or walls and install prior to
   construction of walls or pouring of concrete. Install sleeves flush with all surfaces.

C. Sleeves for underground pipe shall have mechanical rubber seals and be watertight.

D. Floor, wall and ceiling plates shall be pressed steel or cast iron split plates, chromium
   plated.

E. Pressure gauges shall be UL listed or FM approved for fire service.

2.05 Identification Tags:

A. Identification signs shall be porcelain enameled 18 gauges and shall be affixed
   securely by brass chain to all valves. The signs shall be red in color.
B. Provide an approved laminated valve chart in frame and plexiglass cover showing location and use of each valve, including drain valves. The chart shall be secured in a visible location acceptable to the University.

C. The main drain sign shall be labeled "MAIN DRAIN". Riser drains shall be labeled "RISER DRAIN" or "DRAIN".

D. Auxiliary drain signs shall be labeled "AUXILIARY DRAIN".

E. Inspector's test connection signs shall be labeled "INSPECTOR'S TEST".

F. All water supply control valves shall have a standard sign identifying the portion of the system controlled, noting that the valve shall be kept open, and leaving a blank space for notification information.

G. All isolation valves shall be marked on identification tag whether valve is to be “normally open” (NO) or “normally closed” (NC).

2.06 Drains and Test Piping:

A. All portions of the system shall be equipped with drains of the size specified in NFPA 13. Design sprinkler system that will drain to the riser. All drains, including auxiliary drains, shall be piped to the sanitary sewer system designed to handle full flow from the drain and not to exterior of building. All drain piping and threaded fittings to be galvanized (grooved couplings are not required to be galvanized).

B. Every waterflow switch shall have an inspector's test connection located downstream and piped to the sanitary sewer system designed to handle full flow from the drain.

2.07 Backflow Preventer:

A. A double check backflow prevention assembly shall be installed prior to any sprinkler or standpipe system connected to the City of Austin water distribution system, including connection of pressure maintenance pumps to the building’s domestic water line utilized to fill sprinkler system piping. Backflow preventers are not required for fire sprinkler and standpipe piping connected directly to the campus FWDS.

2.08 Express Drains:

A. A remote express drain line is required for all buildings with floor control assemblies in addition to the main / inspectors test drain. This drain line shall be installed in the remote stairwell from the supply standpipe. The drain line shall be piped to a sanitary sewer.

2.09 Sprinklers:
A. Sprinklers shall be UL listed or FM approved and shall not include O-ring seals. Any sprinkler that incurs damage, is painted, or is sprayed with any obstructive material during construction shall be replaced at no cost to the University. Installation of sprinklers shall be coordinated with other work, including duct and electric fixture installation, to prevent sprinkler obstructions.

B. Sprinklers located less than eight feet above finished floor or that may be subject to mechanical damage shall be provided with guards listed for use with the model of sprinkler installed.

C. Quick-response sprinklers are required throughout all light-hazard occupancies, and may also be installed in ordinary-hazard occupancies for the quick response hydraulic design area reduction per NFPA 13 for utilizing quick response sprinklers. Extended coverage sprinklers may be utilized if proven in the hydraulic calculations.

D. Unless specific aesthetic appearance is required for the project, white or chrome recessed pendent sprinklers with matching escutcheons shall be provided in areas with suspended ceilings, and brass upright sprinklers shall be provided in areas without suspended ceilings. Verify with the UT Project Manager prior to specifying sprinkler type and finish.

E. Where required by the project, sprinklers shall be centered in two directions in ceiling tiles. Pendent sprinklers required to be placed in the center of ceiling tiles, shall be supplied from a return bend that connects to an outlet at the top of the fire sprinkler branch line piping.

2.10 Dry Pipe System:

A. Dry Pipe systems shall only be installed where the area being protected cannot be maintained above 40 degrees F, as required per NFPA 13

B. In areas subject to freezing that cannot be protected by dry type sprinklers on a wet sprinkler system, a dry pipe system shall be installed. Antifreeze loops are not permitted.

C. Pitch dry pipe system piping a minimum of ¼ inch per 10 feet for dry system mains and minimum of ½ inch per 10 feet for dry system branch lines.

D. Provide full length dry pendent sprinklers that connect directly to the dry system branch line tee fittings in areas with suspended ceilings. Do not install dry pendent sprinklers on drops.

E. Provide a tank or riser-mounted air compressor listed for fire protection use and sized to refill the entire dry pipe system within 30 minutes as required per NFPA 13.

F. Utilize the compressor manufacturer’s listed air maintenance device and supervisory air pressure switch to maintain and monitor the dry pipe system air pressure.

G. All dry pipe valves must be externally resettable.
H. Install permanent, typed, local labels at devices showing “HIGH AIR” setting, “LOW AIR” setting, “COMPRESSOR ON” setting, “COMPRESSOR OFF” setting, and “TRIP PRESSURE” setting.

2.11 Preaction Sprinkler System:

A. Provide a double interlock preaction system where the University prefers to eliminate water filled piping within the room, such as special collections, computer rooms, etc.

B. Pitch preaction system piping a minimum of ¼ inch per 10 feet for preaction system mains and minimum of ½ inch per 10 feet for preaction system branch lines.

C. Provide full length dry pendent sprinklers that connect directly to the preaction system branch line tee fittings in areas with suspended ceilings. Do not install dry pendent sprinklers on drops.

D. Provide a tank or riser-mounted air compressor listed for fire protection use and sized to refill the entire preaction system within 30 minutes as required per NFPA 13.

E. Utilize the compressor manufacturer’s listed air maintenance device and supervisory air pressure switch to maintain and monitor the preaction system air pressure.

F. Requirements for detection, preaction system releasing, preaction system monitoring, and the preaction release control panel are noted in Section 5.28.30 of the UT Standards.

G. All Preaction valves must be externally resettable.

H. Install permanent, typed, local labels at devices showing “HIGH AIR” setting, “LOW AIR” setting, “COMPRESSOR ON” setting, “COMPRESSOR OFF” setting, and “TRIP PRESSURE” setting.

PART 3 EXECUTION

3.01 Guarantee:

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him, and shall repair or replace, at no additional cost to the Owner, any part thereof, which may become defective within the period of one (1) year after the date of final acceptance by the Engineer, ordinary wear and tear excepted. Contractor shall be responsible for, and pay for, any damages caused by, or resulting from defects in his work.

3.02 Qualifications:

A. System design and installation shall be supervised by a licensed NICET Level III sprinkler system technician or fire protection engineer with not less than five (5)
years of experience with sprinkler systems. Accurate As-Built drawings shall be required in the form of three hard copies and two copies on CD in the specified Auto CAD format. The signature of the RME or engineer constitutes an affidavit that the statements, representations, and information presented in the submittal constitute a complete operational system conforming to applicable state laws and recognized good engineering practices. All field installation work shall be continuously supervised by a NICET Level II or III sprinkler system technician.

3.03 System Acceptance Testing and Commissioning:

A. Perform acceptance tests according to NFPA 13. Provide copies of test reports to the UT Fire Marshal, UT FSSS, A&E Services, and other interested parties as tests are completed. Prior to acceptance, accurate red-lines must be submitted and required training for UT personnel completed. Provide a complete set including all test results to the Owner at the completion of the project and a copy in each O&M Manual. All Fire Sprinkler Systems to be tagged per State Fire Marshall’s requirements.

3.04 Warranty

A. Warranty must be good for one year.

B. Contractor to respond to all warranty calls within 24 hours. If equipment cannot be repaired at this time, FSSS shall be updated daily with the progress and/or status.

C. See Fire Alarm Warranty

3.05 Training:

A. Contractor shall provide services to instruct Owner's personnel in operation and maintenance of system for a minimum of two 4 hour sessions.

END OF STANDARD
PART 1 GENERAL

1.01 Scope of Standard

A. This standard provides general requirements of The University of Texas at Austin for the design and construction of standpipe systems to include combination standpipe systems. This document is not intended to serve as a guide specification.

B. The design guidelines contained herein include the requirements for fire protection systems at The University of Texas at Austin. It is the intention of this document to provide a minimum standard for fire protection systems at the University so as to provide the highest level of fire safety possible.

1.02 Scope of Work

A. Provide all design and materials required to provide a complete fire protection system to protect the specified building in accordance with design requirements. Antifreeze loops are not permitted. The preference of the University is to connect to the campus Fire Water Distribution System (FWDS) provide code compliant combination wet automatic fire sprinkler and, where possible, automatic standpipe systems, that do not contain alarm valves or local alarm devices, and a minimum 10-psi or 10% safety factor, whichever is greater, without requiring a building fire pump. Jockey Pump, if utilized, must be supplied by domestic water source separate from water source serving standpipe.

B. Reference Standards (Utilize latest editions available):
   2. NFPA 14- Standard for the Installation of Standpipe and Hose Systems.
   5. NFPA 20-Standard for the Installation for Fire Pumps
   6. NFPA 72-National Fire Alarm and Signaling Code
   8. IBC-International Building Code

[SEE JOCKEY PUMP/PRV DETAIL IN THE 5.21.40 SECTION.]

C. Standpipe systems must be installed where required by NFPA 101 or the latest edition of the International Building Code. All standpipe systems shall be Class I in all cases, regardless of minimum code requirements, and designed per the latest edition of NFPA 14. 2-1/2” hose valves are required at the intermediate stair landings within the required stairwells per NFPA 14 unless approved by the City of Austin. This may require a standpipe riser in each intermediate landing of all stairs and a separate fire sprinkler riser located in one main stair landing. Provide standpipe isolation control valves with tamper switches for each standpipe as required per NFPA 14. Locate isolation control valves within the stair enclosure and exposed for maintenance purposes.
D. The work addressed in this section consists of a fire protection system, which may include coordination with one or more of the following:
1. Fire Alarm Systems
2. HVAC and smoke control systems and fire, smoke, and combination fire/smoke dampers.
3. Emergency power systems.
5. Central control and monitoring system.

1.03 Related Work: References/Quality Assurance

A. The University, the International Building Code, National Fire Codes as published by the National Fire Protection Association (NFPA), State Fire Marshal, and The University of Texas Fire Marshal’s requirements contain fire protection criteria and requirements for the design of all fire suppression systems. The project shall conform to the following:

B. Conform to a minimum of the latest edition of NFPA 14 for standpipe systems. Insurer may require design in excess of NFPA 14.

1.04 Submittals

A. The University of Texas Project Manager shall review and distribute all submittals for approval by the University insurer, the UT Fire Marshal, UT FSSS, the Owner’s representative, and others as appropriate.

B. Refer to provisions established in the Project Specifications and in related section of Division 01 – General Requirements. All product data shall be submitted under provisions of Division 01.

C. Manufacturer’s data sheets shall be provided for all materials and equipment for approval before purchase or installation. Data sheets shall describe the type of material, capacities, manufacturer, part numbers of equipment, and give information necessary for verifying equipment approval.

D. The Contractor shall submit detailed and accurate shop drawings prepared in accordance with NFPA 13, NFPA 14, NFPA 20, and NFPA 24 for approval of all equipment to be constructed and installed. Shop drawings shall identify all materials and list all equipment to be used. Shop drawings shall include ceiling grid or reflected ceiling layout and shall be coordinated with other trades prior to submittal. Shop drawings are to be submitted with a minimum 1/8” scale and all details at a minimum 1/4” scale.

E. Hydraulic calculations for standpipe systems shall comply with NFPA 13 and shall include comprehensive hydraulic data sheets. Provide a 10 psi or 10% safety factor, whichever is greater, for all standpipe system hydraulic calculations.
F. Provide hydraulic calculations for automatic standpipes, where required per NFPA 14, to provide 100 psi when flowing 500 gpm at the most remote standpipe outlet and 250 gpm at each additional standpipe. Provide hydraulic calculations for manual standpipes to demonstrate the pressure available at the top of each standpipe while flowing the demand required per NFPA 14 utilizing both the available water supply and the nominal City of Austin fire truck pumper through the fire department connection.

G. Prior to preparing shop drawings and hydraulic calculations, the design engineer is required to verify the adequacy of the water pressure and other pertinent water supply data from either the campus Fire Water Distribution System (FWDS) or the City of Austin water distribution system, depending on which system will be utilized to supply the new sprinkler and/or standpipe system. Hydrant flow tests performed on the University distribution system shall incorporate erosion control requirements identified in this standard. See 2.10L Field Acceptance. The design engineer shall immediately notify the UT Fire Marshal and Project Manager of the need for testing the appropriate water supply or fire pump, or the need for any special considerations required. The engineer shall provide the record data at the point of the new utility connection as follows:
   1. Building Name and flange elevation (ft)
   2. Test hydrants (hydrant numbers and location) and hydrant elevations (ft)
   3. Flow rate (gpm), static pressure (psi), and residual pressure (psi)
   4. All turning of valves and operation of fire pump to be performed by FSSS. Actual test to be performed by Contractor or Engineer utilizing their own equipment.
   5. If flowing water on campus, the Project Manager shall submit a request for approval to EH&S.

H. No work shall be performed until the University has approved the shop drawings, calculations, and data sheets. The contractor is solely liable for any work performed prior to this approval.

PART 2 PRODUCTS

2.01 Piping and Fittings
   A. Refer to Section 5.21.00.

2.02 Valves
   A. Refer to Section 5.21.00.

2.03 Drains and Test Piping
   A. All trapped portions of the system shall be equipped with drains of the size specified in NFPA 14. Where possible, design a system that will completely drain to the system riser. Where any trapped water exists, provide an auxiliary drain per NFPA 14 and pipe to the sanitary sewer system. Drain valves and lines are to be sized at 1¼”
minimum. All drains must be piped to the sanitary sewer. Drains cannot be piped to the exterior of the building or mop sinks.

B. Every waterflow switch shall have an inspector's test connection located downstream of the water flow switch and piped to the sanitary sewer system. Inspector’s test connections must comply with NFPA 13 and Section 5.21.00 of the UT Standards.

C. A remote express drain line is required for all buildings with floor control assemblies in addition to the main / inspectors test drain. This drain line shall be installed in the remote stairwell from the supply standpipe. The drain line shall be piped to a sanitary sewer.

2.04 Standpipe Systems

A. Where a standpipe system is required to be installed, the standpipe shall be designed as Class I, manual-wet or automatic-wet standpipe as required by NFPA 14 and the IBC.

B. Where a standpipe system is required in a building or area where the temperature cannot be maintained above 40 degrees F at all times, a dry standpipe is required to be installed. Dry standpipe systems installed on campus shall be Class I, manual-dry standpipes as defined by NFPA 14. Provide galvanized pipe, fittings, and hangers for all dry standpipe systems.

C. Each standpipe shall be installed with a UL listed 2-1/2 inch NST fire department hose connection with caps and located in the intermediate stairwell landing with caps on each floor, unless an alternate location is approved by the City of Austin. Where the distance between the stairwells exceeds the criteria indicated in NFPA 14, provide additional hose valves on each floor to maintain the minimum required distance between valve locations. Locate the additional hose valves in UL listed recessed valve cabinets utilizing only 2-1/2” hose valves without the hose.

D. Provide standpipe isolation control valves supervised by the fire alarm system as required per NFPA 14. Locate standpipe isolation valves within stairwells and exposed, unless an alternate location has been approved by the University.

E. Each standpipe shall have a drain sized at 1¼” minimum and be located in accordance with NFPA 14. Each drain shall be piped and discharged to a sanitary sewer. Drains cannot be piped to the exterior of the building or mop sinks.

F. All dry standpipe system piping shall be installed so that the entire system may be drained back to the system riser. Where building conditions do not allow complete system drainage, provide auxiliary drains for all trapped sections of pipe in accordance with NFPA 13. The number of auxiliary drains shall be kept to a minimum and piped to a sanitary sewer.
G. Each dry standpipe shall be provided with an air and vacuum valve installed at the top of each riser. The air and vacuum valve shall be a 1 inch APCO Series 140 air and vacuum valve, manufactured by Valve and Primer Corporation or approved equal.

H. Where required, a conveniently accessible two-way hose connection shall be provided at the roof level. If the building layout and construction permits, penetrations for the roof level hose connection shall be through an exterior wall and not through the roof.

I. Manual wet standpipe systems calculated utilizing the responding fire department pumper truck for the required pressure and flow per NFPA 14 shall be tested utilizing the pumper truck to prove the hydraulic calculations submitted during design.

J. Where a combination sprinkler/standpipe is provided, the floor control assembly supplying the sprinkler system is required to have a check valve per NFPA 14. A secondary drain in the most remote stairwell shall be installed in addition to the drain of the floor control assembly. Refer to Section 5.21.00.

2.05 Fire Department Connections

A. Each fire department connection shall be flush wall-mounted type. Freestanding type fire department connections shall only be installed when approved by The University. Each fire department connection shall consist of a minimum of two 2-1/2–inch inlets with clappers compatible with equipment utilized by the City of Austin Fire Department and equipped with UL listed Knox caps keyed for the City of Austin Fire Department. The fire department connection shall be labeled to indicate the type of system served with raised letters at least one inch in size and cast on the escutcheon plate provided. The fire department connection shall not be less than two feet and not more than 3 feet 6 inches in elevation, measured from the ground level to the centerline of the inlets.

PART 3 EXECUTION

3.01 Guarantee

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him, and shall repair or replace, at no additional cost to the Owner, any part thereof, which may become defective within the period of one (1) year after the date of final acceptance by the Engineer and UT. Contractor shall be responsible for, and pay for, any damages caused by, or resulting from defects in his work.

3.02 Qualifications

A. System design and installation shall be supervised by a licensed NICET Level III sprinkler system technician or fire protection engineer with not less than five (5)
years experience with sprinkler systems. Accurate As-Built drawings shall be required in the form of three hard copies and two copies on CD in the specified AutoCAD format. The signature of the RME or engineer constitutes an affidavit that the statements, representations, and information presented in the submittal constitute a complete operational system conforming to applicable state laws and recognized good engineering practices. All field installation work shall be continuously supervised by a NICET Level II or III sprinkler system technician.

3.03 Microbiological Influenced Corrosion (MIC)

A. Provide testing on the City of Austin water supply or the campus FWDS, whichever will be supplying the new sprinkler and/or standpipe system, in accordance with the University for MIC testing procedures.

B. Utilize methods and procedures for flushing sprinkler and standpipe piping as required by UT for MIC testing.

3.04 System Acceptance Testing and Commissioning

**A. Perform acceptance tests according to NFPA 13 and UT Third Party Testing** Guidelines that apply to fire sprinkler system testing with a representative of UT Austin Fire Prevention Services and FSSS present. Prior to acceptance, accurate red-lines must be submitted and required training for UT personnel completed. Provide copies of test reports to the UT Fire Marshal and Fire Prevention Services and FSSS, as tests are completed. Provide a complete set of all test results to the University at the completion of the project and a copy in each O&M Manual.

3.05 Warranty

A. Warranty must be good for one year.

B. Contractor to respond to all warranty calls within 24 hours. If equipment cannot be repaired at this time, FSSS shall be updated daily with the progress and/or status.

C. See Fire Alarm Warranty
PART 1 GENERAL

1.01 Scope of Standard

A. This standard provides general requirements of The University of Texas at Austin for fire-extinguishing systems other than water-based fire suppression systems. This document is not intended to serve as a guide specification.

B. The design guidelines contained herein include the requirements for fire-extinguishing systems at The University of Texas at Austin. It is the intention of this document to provide a minimum standard for the installation of fire-extinguishing systems at the University so as to provide the highest level of fire safety possible.

1.02 Scope of Work

A. Provide clean agent suppression systems when the project contains an area or room with sensitive equipment or contents, and the University requires a clean agent system to activate prior to the required water based sprinkler system.

B. Provide wet or dry chemical suppression systems where required by the International Building Code, FM Global (FM), or University requirements. Extinguishing systems protecting cooking appliances, hoods, and branch exhaust ducts are required to be wet chemical extinguishing systems as required by the University.

C. The work addressed in this section consists of non water based fire extinguishing, systems which will be coordinated with all of the following:
   1. Fire Alarm Systems
   2. Emergency power systems
   3. Central control and monitoring system.

D. Reference Standards (Utilize latest editions available):
   1. NFPA 17-Dry Chemical Extinguishing Systems
   2. NFPA 17A-Wet Chemical Extinguishing Systems
   3. NFPA 2001-Standard on Clean Agent Extinguishing Systems
   4. UL 300- Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas

1.03 Related Work: References/Quality Assurance

A. FM Global (FM), International Building Code, National Fire Codes as published by the National Fire Protection Association (NFPA) and The University of Texas Fire Marshal’s requirements contain fire protection criteria and requirements for the design of all fire suppression systems. The project shall conform to the following:
   1. Conform to a minimum of the latest edition of NFPA 2001 for clean agent systems, NFPA 17A for wet chemical suppression systems, and NFPA 17 for
dry chemical suppression systems. FM may require design in excess of NFPA requirements.

2. All design shall conform to requirements of FM.

1.03 Submittals

A. The University of Texas Project Manager shall review and distribute all submittals for approval by FM, the UT Fire Marshal, the Owner representative, and others as appropriate.

B. Refer to provisions established in the Project Specifications and in related section of Division 01 – General Requirements. All product data shall be submitted under provisions of Division 01.

C. Manufacturer’s data sheets shall be provided for all materials and equipment for approval before purchase or installation. Data sheets shall describe the type of material, capacities, manufacturer, and part numbers of equipment and give information necessary for verifying equipment approval.

D. The Contractor shall submit detailed and accurate shop drawings prepared in accordance with NFPA 17 and NFPA 17A for wet and dry chemical systems for approval of all equipment to be constructed and installed. Shop drawings shall identify all materials and list all equipment to be used. Shop drawings shall be coordinated with other trades prior to submittal.

E. The Contractor shall submit detailed and accurate shop drawings and calculations prepared in accordance with NFPA 2001 for clean agent systems for approval of all equipment to be constructed and installed as follows:
   1. Submit shop drawings and flow calculations from a UL listed computer program to the authority having jurisdiction and A/E for approval. Total agent discharge time must be shown and detailed by zone.
   2. Include data for each piece of equipment comprising the system including cylinders, manifolds, control panel, and nozzles. Include product data and design calculations bearing stamp of approval of the University. Include calculations that verify system pressures, nozzle flow rate, orifice size, node numbers, piping pressure losses, component flow data and pipe sizes.
   3. Include manufacturer's certificate that system meets or exceeds specified requirements and NFPA 2001.
   5. Include manufacturer's installation instructions.
   6. Indicate detailed pipe layout, hangars and supports, components and accessories.
   7. Project Record Documents: Accurately record exact location of equipment, equipment identification markings, conduit and piping routing details and agent storage positions.
F. No work shall be performed until the University has approved the shop drawings, calculations, and data sheets for the new system. The contractor is solely liable for any work performed prior to this approval.

PART 2 PRODUCTS

2.01 Clean Agent Systems

A. Pipe: Black Steel Pipe: ASTM A 53 seamless or electric resistance welded. Grades A or B, with internal working pressure equal to the maximum pressure of the clean agent system being utilized. ASTM A 120 or ASTM A 53 Class "F" shall not be used.

B. Pipe Joints and Fittings: In accordance with NFPA 2001 for clean agent system being utilized and compatible with piping. Roll groove fittings must be approved by the manufacturer for use with the clean agent system.

C. Pipe Hangers: ASME B31.1, UL or FM approved for sprinkler systems, split clamp up to 2-1/2 inch size, riser clamps over 2-1/2 inch size, adequate for offset of discharge thrust.

D. Escutcheons: Chrome plated pressed or stamped brass, one piece or split pattern, minimum 2-inches larger than opening.

E. Gauges: ASME B40.1, UL 393, and UL 404, 3-1/2 inch diameter cast aluminum case, phosphor bronze bourdon tube, rotary brass movement, brass socket, front recalibration adjustment, black figures on white background, one percent midscale accuracy, scale calibrate in pounds per square inch.

2.02 Wet and Dry Chemical Extinguishing Systems

A. Provide wet chemical extinguishing systems in accordance with NFPA 17A. Where the wet chemical extinguishing system is protecting cooking appliances, hoods, and branch exhaust ducts, the system shall comply with UL 300, Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas. Utilize discharge nozzles, manual actuators, shutoff devices, pipe, and fittings in accordance with NFPA 17A and manufacturer’s requirements.

B. Provide dry chemical extinguishing systems in accordance with NFPA 17. Utilize discharge nozzles, manual actuators, shutoff devices, pipe, and fittings in accordance with NFPA 17 and manufacturer’s requirements.

C. Shut down all sources of fuel and electrical power to all cooking equipment producing heat upon system activation as required per NFPA 17 and NFPA 17A.
D. Monitor wet and dry chemical extinguishing systems with building fire alarm system.

PART 3 EXECUTION

3.01 Guarantee

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him, and shall repair or replace, at no additional cost to the Owner, any part thereof, which may become defective within the period of one (1) year after the date of final acceptance by the Engineer, ordinary wear and tear excepted. Contractor shall be responsible for, and pay for, any damages caused by, or resulting from defects in his work.

3.02 Qualifications

A. System design and installation shall be supervised by a licensed NICET Level III sprinkler system technician or fire protection engineer with not less than five (5) years experience with sprinkler systems. Shop drawings shall be prepared and engineered. Accurate As-Built drawings shall be required in the form of three hard copies and two copies on CD in the specified format. The signature of the RME or engineer constitutes an affidavit that the statements, representations, and information presented in the submittal constitute a complete operational system conforming to applicable state laws and recognized good engineering practices. All field installation work shall be continuously supervised by a NICET Level II or III sprinkler system technician.

3.03 Clean Agent Systems Testing

A. Pressure test entire enclosure with test fan procedures per NFPA 2001, pressurizing protected area both under positive and negative conditions. Confirm that leakage is within system design allowance with a temperature of 70 degrees F. Provide any required follow up tests at no cost to Owner.

B. Test distribution piping and valves, prior to nozzle installation, to 40 pounds per square inch air pressure test, shut valves and compressor. Inspect joints using soap water solution or halide torch or lamp. Maintain minimum test pressure for at least 10 minutes. If pressure drops more than 20 percent during test, repair leaks and retest.

C. Upon completion of installation provide final checkout inspection by factory-trained representative of manufacturer to ascertain proper system operation. Leave system in a fully commissioned and automatic readiness state with circuitry energized and supervised.
D. Conduct a room pressurization test in each protected space to determine the presence of openings that could affect the agent concentration level. Testing must be in accordance with NFPA 2001. If room pressurization testing indicates openings exist that would result in leaks or loss of extinguishing agent, coordinate the proper sealing of the protected space with the General Contractor. Inspect and retest the protected space as necessary until a successful room pressurization test is achieved. Submit copies of successful test results to Owner. Upon acceptance, the complete system may be placed into service.

E. Submit original copies of tests, indicating that factory trained technical representatives of the manufacturer have inspected and tested systems and are satisfied with methods of installation, connections and operation.

3.04 Wet and Dry Chemical Extinguishing Testing

A. Wet chemical systems shall be tested in accordance with NFPA 17A, and dry chemical system shall be tested in accordance with NFPA 17.

B. Submit original copies of tests, indicating that factory trained technical representatives of the manufacturer have inspected and tested systems and are satisfied with methods of installation, connections and operation.

END OF STANDARD
PART 1 GENERAL

1.01 Scope of Standard

A. This standard provides general requirements of The University of Texas at Austin for fire pumps. This document is not intended to serve as a guide specification.

B. The design guidelines contained herein include the requirements for fire pump systems at The University of Texas at Austin. It is the intention of this document to provide a minimum standard for the installation of fire pump systems at the University so as to provide the highest level of fire safety possible.

C. Fire pump assemblies shall include a separate and dedicated jockey pump, apart from jockey pump required to be installed on system or building-side of PRV assembly, if utilized.

1.02 Scope of Work

A. Provide a complete fire pump system as defined by the latest edition of NFPA 20. Portions of the campus have been provided with a dedicated Fire Water Distribution System (FWDS) supplied by existing fire pumps to supply standpipe and sprinkler systems. If the building may be connected to the FWDS, a water flow pump test shall be performed by the contractor with FSSS providing labor to run the test (FSSS will NOT be responsible for the test readings and the contractor shall supply all equipment necessary to obtain the readings including pressure gauges, pitot tubes, etc.) calculations must be provided to the University utilizing the existing FWDS fire pumps to provide the highest pressure and flow demand required for the sprinkler or standpipe system planned for the building, prior to the design and installation of a new building fire pump system. Upon University approval of the calculations and fire pump product data, if the FWDS fails to meet the highest calculated demand, design and procurement of the fire pump system components may be initiated. If the calculations indicate the FWDS fire pumps can provide the required flow and pressure for the building standpipe and/or sprinkler systems, a new fire pump is not required and the system may be connected to the campus FWDS. See standard 5.21.40 Fire Water Distribution System Connection for details concerning connection to the FWDS.

[SEE JOCKEY PUMP/PRV DETAIL IN SECTION 5.21.40.]

B. The work addressed in this section consists of a fire pump system which will be coordinated with all of the following:
   1. Fire Alarm Systems
   2. Emergency power systems
   3. Central control and monitoring system.
   4. Water based fire suppression systems.

C. Reference Standards (Utilize latest editions available):
2. NFPA 14-Installation of Standpipe and Hose Systems.

1.03 Related Work: References/Quality Assurance

A. The University of Texas, State Fire Marshal adopted codes, International Building Code, and National Fire Codes as published by the National Fire Protection Association (NFPA) contain fire protection criteria and requirements for the design of all fire suppression systems. The project shall conform to the following:
   1. Conform to a minimum of the latest edition of NFPA 20 for fire pumps. FM may require design in excess of NFPA 20 and State Fire Marshal adopted codes.
   2. All design shall conform to requirements of NFPA and State Fire Marshal.

1.04 Submittals

A. The University of Texas Project Manager shall review and distribute all submittals for approval by the University insurer, the UT Fire Marshal, UT FSSS, the Owner’s representative, and others as appropriate.
B. Refer to provisions established in the Project Specifications and in related section of Division 01 – General Requirements. All product data shall be submitted under provisions of Division 01.
C. Manufacturer’s data sheets shall be provided for all materials and equipment for approval before purchase or installation. Data sheets shall describe the type of material, capacities, manufacturer, part numbers of equipment, and give information necessary for verifying equipment approval.
D. The Contractor shall submit detailed and accurate shop drawings prepared in accordance with NFPA 13, NFPA 14, NFPA 20, and NFPA 24 for approval of all equipment to be constructed and installed. Shop drawings shall identify all materials and list all equipment to be used. Shop drawings shall include ceiling grid or reflected ceiling layout and shall be coordinated with other trades prior to submittal. Shop drawings are to be submitted with a minimum 1/8” scale and all details at a minimum ¼” scale.
E. Hydraulic calculations for standpipe systems shall comply with NFPA 13 and shall include comprehensive hydraulic data sheets. Provide a 10 psi or 10% safety factor, whichever is greater, for all standpipe system hydraulic calculations.
F. Provide hydraulic calculations for automatic standpipes, where required per NFPA 14, to provide 100 psi when flowing 500 gpm at the most remote standpipe outlet and 250 gpm at each additional standpipe. Provide hydraulic calculations for manual standpipes to demonstrate the pressure available at the top of each standpipe while flowing the demand required per NFPA 14 utilizing both the available water supply
and the nominal City of Austin fire truck pumper through the fire department connection.

G. Prior to preparing shop drawings and hydraulic calculations, the design engineer is required to verify the adequacy of the water pressure and other pertinent water supply data from either the campus Fire Water Distribution System (FWDS) or the City of Austin water distribution system, depending on which system will be utilized to supply the new sprinkler and/or standpipe system. Hydrant flow tests performed on the University distribution system shall incorporate erosion control requirements identified in this standard. See 2.10L Field Acceptance. The design engineer shall immediately notify the UT Fire Marshal and Project Manager of the need for testing the appropriate water supply or fire pump, or the need for any special considerations required. The engineer shall provide the record data at the point of the new utility connection as follows:

1. Building Name and flange elevation (ft)
2. Test hydrants (hydrant numbers and location) and hydrant elevations (ft)
3. Flow rate (gpm), static pressure (psi), and residual pressure (psi)
4. All turning of valves and operation of fire pump to be performed by FSSS. Actual test to be performed by Contractor or Engineer utilizing their own equipment.
5. If flowing water on campus, the Project Manager shall submit a request for approval to EH&S.

H. No work shall be performed until the University has approved the shop drawings, calculations, and data sheets. The contractor is solely liable for any work performed prior to this approval.

**PART 2 PRODUCTS**

**2.01 Fire Pump, Motor, and Controller**

A. The pump furnished for fire protection service shall be supplied with a driver, controller and pump accessory items specified by the pump manufacturer.

B. The pump and controller shall be UL listed and/or FM approved for fire service, per NFPA 20.

C. The fire pump shall be a single stage, centrifugal horizontal split-case pump specifically labeled for fire service.

D. The pump and motor shall be mounted on a common baseplate of formed steel.

E. The pump casing shall be cast iron with 125 pound rated suction, unless the maximum pressure at the suction side of the pump exceeds 125 psi, and 250 pound rated discharge flanges machined to American National Standards Institute (ANSI) dimensions.
F. The pump shall be hydrostatically tested and run tested prior to shipment. The pump shall be hydrostatically tested at a pressure of not less than one and one-half times the no flow (shut off) head of the pump's maximum diameter impeller plus the maximum allowable suction head, but in no case not less than 250 psi.

G. Fittings:
1. The pump manufacturer shall furnish piping accessory items for the pump installation which will adapt the pump connections to the fire protection system and test connection as follows: Fittings subjected to pump discharge pressure shall be ANSI 250 psi rated. Fittings subjected to suction pressure shall be 125 psi rated, unless the maximum pressure at the suction side of the pump exceeds 125 psi.

H. Fire Pump Test Header:
1. Fire Pump Test Header:
a. Provide a fire pump test header with a 2-1/2” hose valve for every 250 gpm of the rated flow of the fire pump per NFPA 20.
b. Size the fire pump test header based on the fire pump rating per NFPA 20.

I. Fire Pump, Motor, and Controller:
1. The main fire pump controller shall be a factory assembled, wired, and tested unit.
2. The controller shall be of the combined manual and automatic type designed for across-the-line type starting. Variable Frequency Drive controllers are not acceptable.
3. The minimum withstand rating of the controller shall not be less than 30,000 Amps RMS Symmetrical at 480 volts.
4. The controller shall include a motor rated combination disconnect switch/circuit breaker, mechanically interlocked and operated with a single externally mounted handle. When moving the handle from "OFF" to "ON", the interlocking mechanism shall sequence the isolating disconnect switch "ON" first and then the circuit breaker. When the handle is moved from "ON" to "OFF" the interlocking mechanism shall sequence the circuit breaker open first, and then the isolating disconnect switch.
5. The controller shall have externally mounted, individual, visible indicators for "Power Available", "Phase Reversal", "Pump Running", and "Run Time On."
6. The controller shall be wired so that the fire pump can be shut down automatically utilizing pump run-timer.
7. Individual "Power Failure", "Phase Reversal" and "Pump Running" alarm contacts shall be wired for connection to the Main Fire Alarm Control Panel, and the FCMS.
8. Where required by NFPA 20, the controller shall be equipped with an automatic transfer switch. Power to the transfer switch shall be supplied by one of the NFPA 20 required power sources.
9. The manufacturer shall test the entire controller assembly prior to shipment. This test shall include each function the controller may be required to perform. The manufacturer shall test the circuit breaker at 300% full load, 600% load, and short circuit current settings. The manufacturer shall perform a high potential test on the controller power circuits at not less than two times the rated voltage plus 1000 Volts. Documentation of the above listed tests shall be submitted before the fire pump acceptance test.

10. Provide an automatic transfer switch on all fire pump controllers.

J. Field Acceptance

1. Upon completion of the pump and sprinkler piping installation, a field acceptance test shall be conducted at minimum, rated, and peak loads of the fire pump by controlling the quantity of water discharged through approved test devices. All acceptance testing outlined in NFPA 20 shall be conducted by installing contractor in the presence of a representative of The University of Texas Fire Prevention Services & Safety Storm Water Management. Documentation of all factory and field tests shall be submitted at the conclusion of the field acceptance test. A&E will not approve any equipment prior to receipt and review of these test results.

2. All tests shall be performed utilizing the fire pump test header.

3. Erosion Control Requirements - Fire pump discharges must be filtered to slow flow velocity and prevent erosion. Utilize a diffuser and follow one of the filtering methods pertinent to the site:
   a. Pervious cover – direct flow to a vegetated area capable of absorbing as much water as possible without causing erosion or damage to existing landscape. To minimize erosion and reduce sediment deposition, controls such as a series of triangular dikes or other sediment erosion controls must be in place between flow and storm drain inlet.
   b. Impervious cover – direct flow to a cleaned area where the discharged water enters a storm drain inlet protected by filtration (e.g. 3 or 4 triangular dikes or hay bales set in series or other sediment erosion controls). All water discharge to the outside of buildings to be approved by EH&S with Storm Water Discharge request filled out by the contractor and approved by EH&S.
   c. If the total water volume is to exceed 10,000 gallons, the discharged water must be de-chlorinated before it enters the storm sewer system either by directing water into a small area where an approved chemical to dechlorinate water (e.g. sodium metabisulfite at 1 cup or 250 mgs per 5 gallons of chlorinated water) can be sprayed into flow to remove chlorine to acceptable levels.
   d. If the total water volume is to exceed 1,000 gallons, the discharge must be directed through an obstacle course that is designed to remove the chlorine through aeration of the water. The obstacle course shall be constructed as referenced in section 3.a. above to minimize erosion, settle out sediment, and allow chlorine to dissipate in the atmosphere.
A. The contractor shall furnish and install a jockey pump coupled to a motor rated for the required pump, not to exceed 5 HP (Maximum), 480 volts, 60 HZ, 3 phase. Jockey pump to be a Grundfos Model CR5-11 or equal.

B. The jockey pump shall be installed in accordance with NFPA 20. All jockey pump valves and sensing lines to be located as required per UT Detail 5.21.40

C. The control valves to and from the jockey pump shall be supervised butterfly valves installed in accordance with this standard.

D. Jockey Pump Controller:
   1. The jockey pump controller shall be factory assembled, wired and tested, and specifically designed for this type of service.
   2. The jockey pump controller shall be UL listed and/or FM approved.
   3. The pressure switch shall have a range of 0-300 psi and have independent high and low pressure settings. The pressure switch shall be mounted inside the controller. The piping connection for the pressure switch shall be installed per UT Detail 5.21.40. The pressure switch set points shall be determined by Professional Services Provider and in accordance with NFPA 20 Appendix A.
   4. The controller manufacturer, prior to shipment, shall hook up and test the jockey pump controller as a completed assembly. This test shall include each function the controller may be required to perform. The manufacturer shall perform a high potential test of the controller power circuits are not less than two times the rated voltage plus 1000 volts. Documentation of the above listed tests shall be submitted prior to the pump acceptance test.
   5. All jockey pumps shall be served by emergency power circuits.

E. Field Acceptance Test:
   1. A field acceptance test of the jockey pump and controller shall be performed by the contractor at the same time as the main fire pump acceptance test. The acceptance test shall include each function the controller may be required to perform including manual start-stop, automatic start-stop, and minimum run timing.

[SEE JOCKEY PUMP/PRV DETAIL IN SECTION 5.21.40.]

PART 3 EXECUTION

3.01 Guarantee

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him, and shall repair or replace, at no additional cost to the Owner, any part thereof, which may become defective within the period of one (1) year after the date of final acceptance by the Engineer, and UT. Contractor shall be responsible for, and pay for, any damages caused by, or resulting from defects in his work.
3.02 Qualifications

A. System design and installation shall be supervised by a licensed NICET Level III sprinkler system technician or fire protection engineer with not less than five (5) years experience with fire pump systems. Shop drawings shall be prepared and engineered. Accurate As-Built drawings shall be required in the form of three hard copies and two copies on CD in the specified AutoCAD format. The signature of the RME or engineer constitutes an affidavit that the statements, representations, and information presented in the submittal constitute a complete operational system conforming to applicable state laws and recognized good engineering practices. All field installation work shall be continuously supervised by a NICET Level II or III sprinkler system technician.

3.03 System Acceptance Testing and Commissioning

A. Perform acceptance tests according to NFPA 13. Provide copies of test reports to the UT Fire Marshal, UT FSSS, A&E Services, and other interested parties as tests are completed. Prior to acceptance, accurate red-lines must be submitted and required training for UT personnel completed. Provide a complete set including all test results to the Owner at the completion of the project and a copy in each O&M Manual. All Fire Sprinkler Systems to be tagged per State Fire Marshall’s requirements.

3.04 Warranty

A. Warranty must be good for one year.

B. Contractor to respond to all warranty calls within 24 hours. If equipment cannot be repaired at this time, FSSS shall be updated daily with the progress and/or status.

C. See Fire Alarm Warranty

END OF STANDARD
1. **OS&Y Gate Valve with Tamper Switch**
2. **Pressure Regulating Valve**
3. **Jockey Pump**
4. **Check Valve**
5. **Backflow Preventer - Double Check Type**
6. **2' Drain Line**
7. **1' Drain Line**
8. **Oil Filled Pressure Gauge**
9. **Jockey Pump Controller**
10. **Sensing Line**
11. **Relief Valve**
12. **Vane Type Waterflow Switch**

**Pressure Regulating Valve**

1. **Domestic Water**
2. **Fire Water Distribution System**

**Jockey Pump**

1. **PRV**
2. **Fire Department Connection**

**Fire Water Distribution System Connection Detail**

**NOTES**

1. **Jockey Pump** shall have 255 feet rated head at 32 GPM flow minimum.
2. **Locate Jockey Pump Discharge Valve** as close to the Sprinkler main as possible with the Sensing Line installed as close to the discharge valve as possible and as far away from the discharge side of the Jockey Pump as possible.
3. **Locate Jockey Pump Discharge Line** a minimum of two feet (24 inches) away from the main water flow switch.

**LEGEND**

- OS&Y Gate Valve with Tamper Switch
- Pressure Regulating Valve
- Jockey Pump
- Check Valve
- Backflow Preventer - Double Check Type
- 2' Drain Line
- 1' Drain Line
- Oil Filled Pressure Gauge
- Jockey Pump Controller
- Sensing Line

**UNIVERSITY OF TEXAS AT AUSTIN**
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**FIRE WATER DISTRIBUTION SYSTEM CONNECTION DETAIL**
**CAMPUS WIDE**

**DRAWN BY:** Waymon Jackson

**SHEET IDENTIFICATION:** FWDS-01

**DRAWING DATE:** February 25, 2004
PART 1: GENERAL

1.01 General Requirements:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section and the ones that follow so that the University may achieve a level of quality and consistency in the plumbing design of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

B. Indicate required service clearances on drawings with dashed lines. Design shall provide for service and maintenance access to all equipment. Service area shall comply with codes and manufacturer’s recommendations and shall be reasonably planned for human access. Project shall provide elevator access to all levels including basement and attic mechanical spaces. Elevators shall be sized and designed for equipment removal.

C. Design shall include plan for removal of all equipment. Plan shall indicate sizes of major pieces of equipment and clearly marked paths of removal and egress for this equipment from point of installed equipment-to-equipment loading area exterior to building. Entire egress path shall be coordinated for removal of equipment. Preference is to remove all equipment through elevators to ground level. Egress paths of equipment through removable louvers or roof cupolas are acceptable provided louver or cupolas locations are crane accessible. Coordinate with structural to add lifting beams as required to move or replace heavy equipment.

D. Building utilities are required to be metered including but not limited to domestic water. Locate hydronic metering equipment inside a machine room. Provide isolation valves to accommodate meter service; include meter bypass and valve strainer configuration for maintenance of meters for removing the meter without shutting down service to the building. The meters should be installed in accessible areas that allow for reading the meters, performing repairs and testing. Mount meter at 42” above finished floor.

[SEE DOMESTIC WATER METERING DETAIL - Appendix ]

E. Include a 0-100 psi pressure gauge on the domestic water header. Also include an electronic pressure sensor on the header, suitable for connection to Owner’s BAS system.

F. Avoid 3½” and 5” pipe diameters.

G. Do not locate plumbing piping or equipment in transformer vaults, elevator hoist-ways, elevator equipment rooms, electrical rooms, or telecommunications rooms.

H. Verify location, available capacity and connection of new building services to existing campus utilities (domestic water, sanitary sewer, natural gas, etc.) with the University.

I. Provide sufficient unions, flanges, and isolation valves to permit removal of equipment.
J. Provide dielectric unions, dielectric nipples or flange insulating gasket kits with a non-dielectric union to join dissimilar piping materials.

K. Slope plumbing systems to permit drainage. Provide drain valves at low points and manual air vents at high points.

L. Conceal piping within building walls, above ceilings or in furred chases. Use exposed piping only in mechanical rooms unless directed otherwise.

M. Provide one-piece (preferred) or split hinge stainless steel escutcheons for piping entering floors, walls, and ceilings in exposed spaces.

N. Coordinate plumbing system design requirements with overall project design objectives with respect to LEED requirements.

O. Provide N+1 redundancy for equipment providing building utility service such as domestic water backflow preventers (piped in parallel) and domestic hot water converters. Redundancy shall also be provided for equipment serving critical applications such as deionized water circulating pumps.

1.02 Codes:

A. Refer to Section 4.01.02 Codes and Standards

1.03 Plumbing Systems Selection:

A. Plumbing

1. Floor drain traps installed in inaccessible areas shall be brought to the attention of the Owner for consideration of priming at that time.

2. Provide one 12”x12” floor sink per pump battery to facilitate multiple condensate lines, and to eliminate trip hazard of condensate lines routed over floors.

3. Refer to section 5.22.20 for water recovery standards, including fin water.

4. Domestic water treatment shall be required at all sites for building domestic hot water loads. Domestic cold water softening should be considered on a case by case basis. Water shall be tested for hardness and treatment system shall be selected to reduce hardness to an acceptable level is equal to or greater than the quality that the City of Austin provides and sized for the building demand. Consult the University for preferred chemical treatment suppliers. Domestic hot water systems shall be protected from excessive scale formation using water softening, chemical addition (per NSF Standards) or other equivalent scale control system, with life cycle cost being the determining factor for selection.
1.04 Plumbing System Warranties

A. All plumbing systems, components and controls shall be provided with a standard warranty (refer to Division 1: Warranties) that shall initiate upon substantial completion of building. Specific plumbing components may have longer warranty periods. Warranty shall be unconditional and include material, labor and response within 24 hours of notification.

END OF STANDARD
PART 1: GENERAL
1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section so that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture
B. MSS SP-69 – Pipe Hangers and Supports – Selection and Application

1.03 Requirements:

A. Metering:

1. Building utilities are required to be metered including but not limited to: domestic water, chilled water, steam condensate, tunnel supplied lab water, irrigation water and natural gas (if tied directly to Texas Gas Service). Locate hydronic metering equipment inside a machine room. Provide isolation valves including bypasses and strainers (where applicable) to accommodate access to service the meter. Meters should be installed in accessible areas that allow for reading the meters, performing repairs and testing. Meters to be installed no more than 42” above finished floor.

2. For buildings with mixed occupancy (E&G and non-E&G), provide sub-metering to properly allocate utility costs between organizations. Coordinate sub-metering requirements with the University.

3. Valve boxes on exterior water-distribution valves shall be adjustable cast iron type. Tyler 6850 valve boxes are an acceptable option or owner approved equivalent. Refer to section 5.23.09 for further utility metering requirements.

B. Valves:

1. Provide valves with extended stems to be accessible on outside of insulation. Valve body and stem shall be insulated.

2. Provide means of access where valves are not exposed.

3. Provide valve vaults or boxes, as conditions demand, to provide access to valves installed below grade.

4. Valves applied to cold water and piping systems with fluids typically less than ambient temperature shall be constructed with all components exposed to atmosphere of stainless steel or brass. Steel components are not acceptable.
C. Hangers and Supports:

1. Design piping systems to utilize pipe hangers, inserts, and supports in conformance with International Mechanical Code, MSS SP-58 and MSS SP-69.

2. Provide hangers fabricated to allow adequate vertical adjustment of 1.5 inches minimum after installation while still supporting the load. The use of pipe hooks, chains, or perforated iron piping for support is prohibited.

3. Support horizontal cast iron pipe adjacent to each hub, with a maximum of five feet spacing between hangers. Support vertical cast iron pipe at each floor at hub.

4. Provide pipe hangers within 12 inches of each change in direction and provide hangers on both sides of line valves.

5. Provide vertical piping support at each floor with 2-bolt riser clamps. For pipe risers exceeding three floors, evaluate pipe supports for longitudinal expansion and support requirements. Support riser piping independently of connected horizontal piping.

6. Provide four inch high concrete housekeeping pads and equipment bases for floor mounted equipment in mechanical rooms and penthouse equipment rooms. Housekeeping pads shall extend a minimum 6 inches beyond the equipment or supported member in all directions. Provide pads with half-inch chamfer on all exposed edges, placed and finished smooth and level to ensure proper and continuous support for the bearing surfaces of equipment.

7. Provide sleeves for all pipe penetrations through walls, roofs, or floors. Provide sleeves larger than pipe to accommodate insulation thickness. Provide sleeves in non-load bearing surfaces fabricated of galvanized sheet metal and sleeves in load bearing surfaces constructed of uncoated carbon steel pipe. Sleeves shall not be installed in structural members unless specifically approved by the University. Caulk all sleeves water and airtight. Provide UL listed sealant between pipe and sleeve as required by code. Provide escutcheons around penetrations in finished areas.

8. Provide Linkseal (or approved equal) assembly for pipe penetrations through waterproofed floors and walls.

9. Where piping penetrates a floor, ceiling or wall, provide fire stopping insulation, sealed airtight, to close off penetration space between pipe, ductwork, and adjacent work. Provide escutcheon covers at both sides of penetration.

10. Where piping penetrates a fire rated floor, wall, or ceiling, provide fire-safe insulation so that the assembly, when complete, is UL listed and equals the fire rating of constructed penetrated.

11. Provide pumps with concrete-filled, spring-isolated inertia bases installed on top of concrete housekeeping pad.
D. Vibrations and Sound Control:
   1. Provide flexible connectors for piping connections to rotating equipment. For pipe systems 2 inches and smaller, provide braided stainless steel flexible connectors. For pipe systems 2 inches and larger, provide Kevlar reinforced rubber, double-sphere flanged flexible connectors.

PART 2: PRODUCTS

2.01 Motors:
   A. Refer to standard 5.26.60 Electric Motors for motor standard.

2.02 Valves:
   A. Shut off and Section Valves:
      1. 2” and smaller: Provide ball valves.
      2. 2½” or larger: Provide ball valves or gate valves.
   B. Drain Valves:
      1. 2” and smaller: Provide ball valves.
      2. 2½” and larger: Provide gate valves.
   C. Check Valves:
      1. Provide spring-loaded silent check valves.

PART 3: EXECUTION

2.01 Pipe Testing Procedures:
   A. Refer to Appendix for plumbing pipe testing procedures.

END OF STANDARD
PART 1: GENERAL
1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section so that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

B. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation
C. ASTM C534 – Preformed Flexible Elastomeric Cellular Thermal Insulation
D. ASTM C547 – Mineral Fiber Preformed Insulation
E. ASTM C552 – Cellular Glass Block and Pipe Thermal Insulation
F. ASTM C612 – Mineral Fiber Block and Board Thermal Insulation
H. MSS SP-69 Pipe Hangers and Supports – Selection and Application

1.03 Requirements:

A. Provide insulation and associated accessories with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

B. Provide piping insulation thickness and thermal conductivity in conformance with the latest edition of ASHRAE 90.1.

C. Provide pipe insulation continuous through walls, partitions, ceiling openings and sleeves.

D. Provide UL-approved assemblies for pipes passing through fire-rated floors, walls, or partitions as required.

E. Provide a continuous, unbroken, vapor seal on all cold pipe surfaces. Guides and anchors secured directly to cold surfaces shall be adequately insulated and vapor sealed to prevent condensation. Pipe Insulation shall run continuously through supports and hangers. Use high compression strength insulation section at support hanger and cover with galvanized steel shield.

F. Provide aluminum jackets, 0.016” thick, for exterior pipe and equipment insulation covers. For interior piping in mechanical rooms or exposed locations, provide aluminum jackets, 0.016” thick for all piping below 6 feet above finished floor. Locate seams on bottom side of horizontal pipe.
G. Jackets for piping insulation shall conform to requirements of ASTM C921, Type II for piping with temperatures above ambient.

H. Provide insulation protection shields fabricated from galvanized steel at all pipe hangers in accordance with MSS SP-69.

I. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations.

J. Provide staples, bands, wires, cement, adhesives, sealers, and protective finishes as recommended by insulation manufacturer for applications indicated.

K. Provide flexible reusable insulation blankets for equipment requiring access such as pumps, strainers, etc.

L. Insulate valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut units.

M. For main loop chilled water piping insulation, utilize the Utilities and Energy Management specifications. The scope of this piping insulation is for the main chilled water loop through the discharge valve of the primary chilled water pumps.

**PART 2: PRODUCTS**

2.01 Piping Insulation Materials:

A. Rigid Phenolic Insulation: Shall be CFC free and meet or exceed requirements of ASTM C1126, Type III, Grade 1 to 250° F service. Provide with factory-applied jacket suitable for the installation location.

B. Calcium Silicate: Shall meet or exceed the requirements of ASTM C533, Type I. Provide insulation with manufacturer’s recommended jacket.

C. Fiberglass Piping Insulation: Shall meet or exceed requirements of ASTM C552, Class 1, noncombustible, with factory applied white Kraft foil vapor barrier unless otherwise indicated.

D. Flexible Elastomeric Closed Cell: Shall meet or exceed requirements of ASTM C534, Type I, tubular grade. Provide finish coating.

E. Cellular Glass: Shall meet or exceed requirements of ASTM C552, Type II. Provide factory cover and vapor retarder finish.

2.02 Equipment Insulation Materials:

A. Mineral Fiber: Shall meet or exceed requirements of ASTM C 547, C553, Types I, II or III or C612, whichever applies. Provide with factory-applied jacket.

B. Calcium Silicate: Shall meet or exceed the requirements of ASTM C533, Type I or II. Provide insulation with manufacturer’s recommended jacket.

C. Flexible Elastomeric Cellular: Shall meet or exceed the requirements of ASTM C534, Grade 1, Type I or II. Provide Type II with vapor retarder skin on one or both sides of insulation.
2.03 Ductwork Insulation Materials:

A. Fiberglass Ductwork Insulation:

1. Fiberglass Blanket insulation with a density of 1 pound per cubic foot and thermal conductivity (k value) of 0.29 @ 75 °F mean temperature. The blanket shall have a vapor barrier facing of an aluminum foil and Kraft paper lamination sandwiching a fiberglass scrim for reinforcing.

2. Rigid Fiberglass Board: Three pound per cubic foot minimum density glass fiber rigid board insulation with factory applied white foil reinforced All Service Jacket (ASJ).

3. Semi-Rigid Fiberglass Board: Three pound per cubic foot minimum density glass fiber semi-rigid board insulation with fiber perpendicular to the surface and with factory applied white foil reinforced vapor barrier jacket (ASJ). Insulation shall be equal to E.O. Woods Company “Rigid-Wrap.

B. Flexible Unicellular: Flexible Unicellular insulation blanket, protected by Armaflex finish protective coating (minimum 2 coats).

C. Ductwork Insulation Accessories: Provide Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

D. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

E. Ductwork Insulation Sealing: Blanket insulation with a thermal conductivity of 0.27 or less similar in construction to Owens-Corning Fiberglass Series one pound per cubic foot minimum density with foil reinforced Kraft (FRK) vapor barrier facing. Insulation shall be wrapped tightly on the ductwork with all circumferential joints butted and longitudinal points overlapped a minimum of 2”. Adhere the insulation to metal with 4” strips of insulation bonding adhesive at 8” on center. On circumferential and longitudinal joints, the 2” flange of the facing shall be secured 9/16” flare door staples applied 6” on center and taped with 4” wide fiberglass tape embedded in Childers CP-10 white vapor barrier emulation and covered with Childers CP-10 until the tape is completely covered. All pin penetrations or punctures in facing shall also be taped. Vapor sealing of joints is not required on hot duct application where concealed.

PART 3: EXECUTION

3.01 Piping System Insulation:

A. Plumbing System Omissions: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.

B. HVAC Piping System Omissions: Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.

C. Steel piping insulated with rigid phenolic shall be coated with epoxy finish prior to insulation installation.
D. Insulate piping systems per table 23.07.1. [See below]

**Table 23.07.1**

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>MATERIAL</th>
<th>VAPOR BARRIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChW supply/return</td>
<td>Cellular Glass</td>
<td>Yes</td>
</tr>
<tr>
<td>Fin Water</td>
<td>Flexible Elastomeric Closed Cell</td>
<td>Yes</td>
</tr>
<tr>
<td>Existing wet ChW piping, tunnel ChW piping, primary ChW piping in machine rooms.</td>
<td>Cellular Glass</td>
<td>Yes</td>
</tr>
<tr>
<td>Heating Hot Water supply/return (max. 250 °F), Steam Condensate</td>
<td>Mineral Fiber, Calcium Silicate</td>
<td>No</td>
</tr>
<tr>
<td>Low Pressure Steam (max. 250 °F)</td>
<td>Calcium Silicate</td>
<td>No</td>
</tr>
<tr>
<td>Potable Cold Water, make-up water, drinking water, fountain drain, roof drain piping</td>
<td>Flexible Elastomeric Closed Cell or Phenolic Foam</td>
<td>No, Yes</td>
</tr>
<tr>
<td>Potable Hot Water supply/return (max. 200 °F)</td>
<td>Fiberglass or Phenolic Foam</td>
<td>No</td>
</tr>
<tr>
<td>Refrigerant Suction</td>
<td>Flexible Elastomeric Closed Cell</td>
<td>No</td>
</tr>
</tbody>
</table>

3.02 Equipment Insulation:

A. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around nameplates.

B. Insulate the following equipment per Table 23.07.2: Cold refrigeration equipment not factory insulated, drip pans under chilled equipment, cold and hot water storage tanks, water softeners, cold water pumps, roof drain bodies, expansion and air separator tanks, heat exchangers, hot water generators, water heaters, and pumps handling media above 130°F, except pumps on steam condensate return units. This requirement would include condensate receivers. If there is not a flash tank upstream of the receiver, then a leaking low-pressure trap would heat the condensate receiver well above the 212 °F. This temperature causes the condensate pumps to fail. Leave the condensate receivers uninsulated to help protect the pumps. (Put into Steam and Condensate 5.23.22)

**Table 23.07.2**

<table>
<thead>
<tr>
<th>EQUIPMENT HANDLING MEDIA AT INDICATED TEMPERATURE</th>
<th>INSULATION MATERIAL</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 34 degrees F</td>
<td>Flexible Elastomeric Closed Cell or Cellular Glass</td>
<td>2.0 inches</td>
</tr>
<tr>
<td>35 to 60 degrees F</td>
<td>Closed Cell or Cellular Glass</td>
<td>1.0 inches</td>
</tr>
</tbody>
</table>
22 07 00 – PLUMBING INSULATION
DESIGN AND CONSTRUCTION STANDARD

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Insulation Material</th>
<th>Required Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 to 200 degrees F</td>
<td>Mineral Fiber</td>
<td>2.0 inches</td>
</tr>
<tr>
<td></td>
<td>Calcium Silicate</td>
<td>2.0 inches</td>
</tr>
<tr>
<td>201 to 400 degrees F</td>
<td>Calcium Silicate</td>
<td>4.0 inches</td>
</tr>
<tr>
<td>401 to 600 degrees F</td>
<td>Calcium Silicate</td>
<td>6.0 inches</td>
</tr>
<tr>
<td>&gt;600 degrees F</td>
<td></td>
<td>Thickness necessary to limit external insulation temperature to 120 degrees F</td>
</tr>
</tbody>
</table>

3.03 Duct System Insulation:

A. Double-wall ductwork shall be provided where internal insulation or sound absorbing linings have been provided.

B. Hot and cold interior ductwork shall be insulated with Flexible Fiberglass insulation. Provide thickness to achieve minimum R-value requirements per ASHRAE 90.1.

C. Exterior ductwork shall be insulated with Flexible Closed-Cell Elastomeric insulation. Provide with aluminum jacketing sealed water tight. Slope insulation on top of ductwork to promote drainage.

D. Ductwork Insulation Sealing:

END OF STANDARD
PART 1: GENERAL

1.01 Purpose

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section so that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

B. Reference ASME A17.1 for elevator sumps and sump pump requirements.

1.02 Codes and Standards

A. Plumbing Code Compliance: Comply with applicable portions of International Plumbing Code pertaining to selection and installation of Plumbing materials and products. Note that the City of Austin (COA) follows the Uniform Plumbing Code and all systems that interface with COA infrastructure must comply accordingly.

B. Plumbing and Drainage Institute: WH-201.

C. ASSE 1013 – Performance Requirements for Reduced Pressure Principle Backflow Preventers.

D. ASSE 1003 – Performance Requirements for Water Pressure Reducing Valves.

E. ASME Boiler and Pressure Vessel Code.

F. HI Compliance: Design, manufacture, and install plumbing pumps in accordance with “Hydraulic Institute Standards.”

G. UL Compliance: Design, manufacture, and install plumbing pumps in accordance with UL 778 “Motor Operated Water Pumps.”

H. SSPMA Compliance: Test and rate sump and sewage pumps in accordance with SUMP and Sewage Pump Manufacturers Association (SSPMA) and provide certified rating seal.


1.03 Requirements

A. Provide water hammer arrestors, complete with accessible isolation valve, in hot and cold water lines at the end of each battery of plumbing fixtures and at each plumbing fixture location remote from a battery of fixtures. Size in accordance with PDI WH-201.

B. Isolate domestic water lines for building services from cross connection by means of two code-approved backflow preventer in for each water feed to the building. Provide additional backflow prevention devices in process water connections and fire system connections off the main building service.
C. Provide backflow preventers at any connection between potable and non-potable water systems.

D. Provide clean-out capability for domestic hot water return piping in recirculating loops. Provide a capped tee fitting at each ninety-degree turn in the piped return system.

E. Route groups of pipes parallel to each other with spacing to allow for insulation and valve service.

F. Provide dielectric couplings at connections between dissimilar metals.

G. Provide sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections.

H. Provide shutoff valves installed on inlet of each plumbing equipment item and on inlet of each plumbing fixture.

I. Provide drain valves at equipment, bases of risers, and low points in system to completely drain potable water system.

J. Provide soft-seat check valves on discharge side of each pump.

K. Provide balance cocks in each hot water recirculating loop.

L. In all cases, Designer shall evaluate system conditions and select the optimum pump type and configuration based on pump efficiency and characteristics.

M. Recommend in-line circulating pumps or close-coupled end suction pumps for low flow (up to 50 GPM) circulating systems.

N. Recommend base-mounted end suction pumps for circulating systems with flow rates between 50 and 500 GPM.

O. Pumps furnished as part of factory-fabricated equipment, such as a part of booster pump skids, are to be end-suction, if available.

P. Provide all booster pumps with a valved bypass line to facilitate maintenance.

Q. Cleanouts for fixture banks shall be located above fixture flood level.

R. Provide dedicated shutoff valve for outdoor hose bibs and fixtures.

PART 2: PRODUCTS

2.01 Pipes and Pipe Fittings

A. Pipe Size 2" and Smaller
1. Copper tube; Type "L", hard-drawn wrought-copper fittings, solder-joints. Use Dutch Boy or Silvabrite 100 lead-free solder, Composition 95/5, Solder Filler Metals: ASTM B 32, Solder containing lead is not permitted.

2. Copper Tube; Type "L" with copper Press Fittings with rubber O-rings made with hydraulic compression tool, Viega ProPress or approved equal.

3. Piping smaller than ¾” shall not be allowed.

B. Pipe Size 2 1/2 and Larger:

1. Copper tube; Type "K", hard-drawn wrought-copper fittings, brazed sil-fos-joints manufactured by Silfos, Solder Filler Metals: Solder containing lead is not permitted.

2. Copper Tube 2-1/2 to 4”; Type "K", with copper Press Fittings with rubber O-rings and stainless steel grip ring made with hydraulic compression tool, Viega ProPress or approved equal.

C. Piping 6” and larger shall be ASTM A53 galvanized steel pipe, schedule 40, with rolled grooved ends and mechanical couplings.

D. Exterior below grade or below concrete slab equipment or fixture supply feeds: Piping shall be Type K copper, soft-annealed temper, with wrought copper fittings and lead free jointing.

E. Below building concrete slab - Tube size ¾" and larger: type "K" soft - annealed copper coil tubing. Copper tubing installed below building concrete slab on grade shall be installed without solder joints.

F. Underground water main piping systems: All pipe used for underground water piping mains shall be Class 50 ductile iron pipe, arranged with bell and spigot mechanical joints, fully restrained with retaining glands. Class 51 for 3” and 4” and Class 50 for 6” and larger,

2.02 Piping Specialties

A. Provide basket strainers with cast-iron body, 125-psi flanges, bolted type or yoke type cover. Furnish with removable, non-corrosive perforated strainer basket, with 1/8" perforations and lift-out basket handle.

2.03 Bibbs and Faucets

A. Hose Bibbs shall be threaded end, bronze body, renewable composition disc, tee handle, ¾" NPT inlet, and ¾" hose outlet. Provide with vacuum breaker.

B. Sill Faucets shall be bronze body, renewable composition disc, wheel handle, ¼" solder inlet, ¾" hose outlet. Provide with vacuum breaker.

2.04 Hydrants

A. Recessed Non-Freeze Wall Hydrants: Case-bronze casing, length to suit wall thickness, vacuum breaker, hinged locking cover, ¾” inlet, and hose outlet.
B. Project Non-Freeze Wall Hydrants: Cast-bronze hydrant, chrome plate face, tee handle key, bronze casing, length to suit wall thickness, vacuum breaker, ¾” inlet, hose outlet.

C. Projected Non-Freeze Wall Hydrants: Cast bronze hydrant, chrome-plated face, tee handle key, bronze casing, length-to-suit wall thickness, vacuum breaker, ¾” inlet, hose outlet.

D. Floor Level Non-Freeze Hydrants: Bronze hydrant, rough bronze box, tee handle key, bronze casing, length to suit depth of bury, drain hole, vacuum breaker, hinged locking cover, ¾” inlet, hose outlet.

E. Non-Freeze Post Yard Hydrants: Bronze hydrant, tee handle key, bronze casing with cast-iron casing guard, length to suit depth of bury, drain hole, vacuum breaker, ¾” inlet, hose outlet.

2.05 Backflow Preventers

A. Shall be of the reduced pressure zone (RPZ) type. The assembly shall include shutoff valves on inlet and outlet, and strainer on inlet. Backflow preventers shall include test cocks, and pressure-differential relief valve located between 2 positive seating check valves. Construct in accordance with ASSE Standard 1013. Coordinate the exact model of the backflow preventer with the University prior to incorporation into the design.

B. Provide backflow preventers at any connection between potable and non-potable water systems. Refer to Products section.

2.06 Pressure Regulating Valves

A. Shall be single seated, direct operated type, bronze body, integral strainer, complying with requirements of ASSE Standard 1003. Provide inlet and outlet shutoff valves and throttling bypass valve. Provide pressure gauge on valve outlet.

2.07 Relief Valves

A. The standard relief valves shall be manufactured in accordance with ASME Boiler and Pressure Vessel Code. Valves shall be combined pressure-temperature relief valves with bronze body, test lever, thermostat and shall comply with ANSI 21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 °F and pressure relief at 150 psig.

2.08 Pumps

A. In-Line Re-Circulation Pumps

1. Provide maintenance-free circulator pumps designed for 125 psig working pressure 225 °F continuous water temperature and specifically designed for quiet operation.

2. Body: Stainless steel fitted construction with iron body.

3. Shaft: Steel, ground and polished, metal impregnated carbon thrust bearing.
4. Motor: Non-overloading at any point on pump curve, open, drip proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.


B. Water Pressure Booster System

1. General: Provide factory-fabricated and tested water pressure booster system consisting of diaphragm type water tank, centrifugal pumps, power and control panels, instrumentation, and operating controls. It is a University Standard to provide pumps with a valved bypass to facilitate maintenance.

2. Pumps: Provide two (2) constant speed, single stage, end-suction design, cast-iron; bronze fitted centrifugal pumps with mechanical shafts seals. Mount pumps on vibration insulators. Provide temperature probe and electric purge valve immediately upstream of each PRV. Provide drip-proof motors.

3. Water Tank: Provide factory pre charged diaphragm type water tank with replaceable flexible membrane. Construct in accordance with ASME Code and provide ASME stamp for 125-psi minimum.

4. System Controls: Maintain system pressure with pilot-operated diaphragm type combination pressure regulating and non-slam check valve on each pump discharge line.
   a) Provide low system pressure switch located on discharge header to sense drop in system pressure, and to activate alarm and automatically start standby pump.
   b) Provide adjustable vane type flow switch to sequence lag pump.

C. Control Panel Enclosure:

1. Provide UL-listed, NEMA l, hinged door, and lockable control panel enclosure.

D. Duplex Pedestal Type Sump Pumps:

1. Pump: Duplex, centrifugal, semi-open impeller type sump pump, complete with galvanized steel strainer, cast-iron base plate, suction plate and casing, and cast-iron or bronze impeller.

2. Shaft: Stainless steel of length to suit depth of basin, connected with flexible coupling to motor, and intermediate sleeve bearing for lengths over 4'.

3. Motor: Open drip-proof, electrical characteristics as scheduled.

4. Basin: Fiberglass construction of indicated dimensions, with inlet connections of size and location as indicated. Maintain minimum of 3' depth below lowest inlet invert.
5. Cover: Cast-iron or steel circular cover with manhole or hand hole opening, depending on diameter. Provide openings for pump, control rod, and discharge piping.

6. Controls: Pump controls shall include float switch with gas-tight seals, bronze or stainless steel floats and rods, alternator, high level automatic alarm switch with gas-tight seals Auxiliary BAS alarm contacts and provisions for activation of a remote alarm light. Control panel shall be a factory-wired NEMA Type 1 (non-metallic) enclosure and shall include (HOA) two hand-off-auto switches, electric auto alternator circuit, combination motor controller with circuit breaker, control power transformer, and pump running lights. Alarm switch and all controls shall operate on 120 VAC (fuse protected circuit), 60 hertz, U.L. 508 listed industrial controls label.

7. Provide main disconnect switch.

E. Submersible Sump Pumps:

1. Pump: Cast-iron shell, bronze impeller, stainless steel shaft, factory-sealed grease lubricated ball bearings, ceramic mechanical seal, and perforated steel strainer.


4. Provide with stainless steel safety/lifting chain or slide rail system.

5. Provide connections points in piping to facilitate rapid tie-in of temporary pumps during emergency situations.

6. Controls: Pump controls shall include float switch with gas-tight seals, bronze or stainless steel floats and rods, alternator, high level automatic alarm switch with gas-tight seals Auxiliary BAS alarm contacts and provisions for activation of a remote alarm light. Control panel shall be a factory-wired NEMA Type 1 (non-metallic) enclosure and shall include (HOA) two hand-off-auto switches, electric auto alternator circuit, combination motor controller with circuit breaker, control power transformer, and pump running lights. Alarm switch and all controls shall operate on 120 VAC (fuse protected circuit), 60 hertz, U.L. 508 listed industrial controls label.

7. Provide main disconnect switch.

F. Duplex Sewage Ejector Pumps:

1. Pump: Duplex (Two) centrifugal, self-priming, solids handling pumps with a cast iron body and cast iron or ductile iron impeller.

2. Shaft: Carbon steel, connected with flexible coupling to monitor.
3. Motor: Open drip-proof, electrical characteristics as scheduled.

4. Basin: Fiberglass construction of indicated dimensions, with inlet connections of size and location as indicated. Maintain minimum of 4’ depth below lowest inlet invert.

5. Cover: Cast-iron or steel circular cover with manhole or hand hole opening, depending on diameter. Provide openings with gas tight seals for controls, vent, and suction piping.

6. Controls: Pump controls shall include float switch, bronze or stainless steel floats and rods, alternator, high level automatic alarm switch, Auxiliary BAS alarm contacts and provision for activation of a remote alarm light. Control panel shall be a NEMA Type 1 (non-metallic) enclosure and shall include (HOA) two hand-off-auto switches, electric auto alternator circuit, combination motor controller with circuit breaker, control power transformer, and pump running lights. Alarm switch and all controls shall operate on 120 VAC (fuse protected circuit), 60 hertz, U.L. 508 listed industrial controls label.

7. Provide main disconnect switch.

PART 3: EXECUTION

3.01 Pipe Testing Procedures:

A. Refer to 6.02.10 Appendix: Pipe Testing Procedures for plumbing pipe testing procedures.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section so that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References

A. Codes and Standards that are Standards at the University

B. Design plumbing systems in accordance with the latest version of the International Plumbing Code. Design shall conform to Uniform Plumbing Code requirements where interaction occurs with City of Austin utilities.

1.03 Requirements

A. Provide floor drains in all toilet rooms, janitor closets, and mechanical rooms.

B. Extend cleanouts to finished floor or wall surface, with access covers installed flush to the finished surface. Ensure clearance at cleanout for rodding of drainage system.

C. Coordinate cleanout locations with Architect.

D. Encase exterior cleanouts in concrete with access cover installed flush with grade.

E. Provide grease traps (interceptors) whenever there is the potential to discharge wastes containing fats, oils, greases, and/or settable solids into the sanitary sewer system.

F. Grease traps shall have two compartments, with the primary having a seven-minute retention time and the secondary having a five-minute retention time. For cleaning and inspection purposes, traps shall be located in area accessible to appropriate grease recovery equipment and have adequate cleanouts installed for access to all inlet and outlet piping. Manufactured traps that are properly sized may be used in lieu of on-site construction. When possible, the trap shall be installed outside the building. Note that all retention times shown are minimums.

G. Buried grease traps shall be constructed of concrete.

1. Where grease trap is located exterior to building, all pipe and fittings shall be Schedule 40 PVC. Normally traps will be installed 3½” below grade, but in areas subject to vehicle traffic, shall be 8” below grade and equipped with traffic manhole frame and cover.

2. Traps inside building shall receive cast-iron pipe and fittings.

3. Some consultants have questioned the use of polypropylene piping (water and drainage) in return air plenum spaces. PP does not conform to 25/50 (flame and smoke) code requirements for plenum use; PVDF polyvinylidene fluoride and CPVC Lab waste
carries the 25/50 rating. Also we have had problems with fuseal type connections that leak.

PART 2: PRODUCTS

2.01 Above Ground Drainage and Vent Pipe and Fittings

A. Cast-Iron Soil Pipe: ASTM A74, Service weight, hubless pipe and fittings.

B. Heavy Duty Couplings for Hubless Cast-Iron Soil Pipe: Hubless Clamps, heavy weight, stainless steel bands. Clamps shall be constructed and tested per ASTM C-1277. For pipe sizes 1-1/2” through 4” minimum four (4) bands and for pipe sizes 5” through 15” minimum six (6) bands.

C. Polypropylene Pipe and Fuseal Fittings (or Engineer-approved equal): use for acid waste and vent piping in laboratories

UT Austin Facilities Services recommends using Fuseal Fittings from this document and any use of fuseal in the standards. These must be mechanical fittings with no thermal weld.

2.02 Underground Drain Pipe and Fittings

A. Cast-Iron Soil Pipe: ASTM A74, Service weight, hub-and-spigot soil pipe and fittings. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces.

B. Neoprene Compression Gaskets: ASTM C564.

C. Sewer Pipe and Fittings: Conform to ASTM D2729 for pipe and fittings.

2.03 Drainage Piping Specialties

A. Expansion Joints: Cast-iron body with adjustable bronze sleeve, bronze bolts with wing nuts.

B. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.

C. Floor Cleanouts: Cast-iron body and frame, with cleanout plug and adjustable round nickel bronze top.

D. Wall Cleanouts: Cast-iron body adaptable to pipe with cast-bronze or brass cleanout plug; stainless steel cover including screws.

2.04 Floor Drains

A. Floor drains shall be provided with deep seal “P” traps at all floor drains.

B. Floor Drain (Basement and air handler rooms) 12” x 12” floor sink with half-grate strainer, ty-seal or caulked outlet, dura-coated. Similar to Zurn Z-567. There shall be adequate floor drains.
to provide drain for all equipment requiring same; one per piece of equipment, to eliminate excessive drain piping across floors.

C. Floor Drain (for boiler rooms): Cast-iron body and tractor grate, flashing flange and collar.

D. Floor Drain (corridors): Stainless steel body with flashing collar, ty-seal or caulked outlet and adjustable strainer head, stainless steel round strainer with satin finish.

E. Floor Drain (mechanical rooms, storage rooms and other remote areas) shall be provided with a central piped primer system which automatically primes traps building wide using a single timed valve for one minute every 24 hours (adjustable).

2.05 Depressed Area Drains

A. Floor Drain (depressed area drains): Cast-iron body for horizontal mounting secured grate.

B. Floor Drain (medium to heavy traffic and drainage): Cast-iron body and flashing collar with adjustable top and tractor grate.

C. Floor Drain (shower and toilet rooms): Cast-iron body and flashing collar with the following features, square nickel bronze adjustable strainer head with secured square hole grate.

2.06 Trench Drains

A. Cast-iron shallow hub body and grate with end plates and gaskets, assembled in standard lengths for total length and width as required for application.

B. Non-Metallic Trench Drains shall be polyester resin and quartz aggregate, precast, interlocking design, with bottom radius and 0.6 percent slope.

C. Precast Material: Load pressure of 14,500 psi, bending pressure of 2,900 psi, frost-proof, salt-proof, inert under dilute acid and alkali conditions, and less than 1.0 percent water absorption rate.

D. Grates: Cast iron or steel as indicated, for heavy-duty truck traffic, with openings designed to prevent entry of bicycle or wheelchair tires.

2.07 Roof Drains

A. Roof Drain (General Purpose): Cast-iron body with combined flashing collar and gravel stop, cast-iron dome.

B. Roof Drain (controlled flow): Cast-iron body, combined flashing collar and gravel stop, cast-iron dome with adjustable flow rate control assembly.

C. Roof Drain (parapet roofs): Cast-iron body, flashing device, loose set grate.

2.08 Grease Traps

A. Size traps according to the following criteria:


<table>
<thead>
<tr>
<th>Kind of Fixture</th>
<th>Trap and Trap Arm Size</th>
<th>Fixture Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 compartment sink</td>
<td>1 ½”, 2”</td>
<td>3, 4</td>
</tr>
<tr>
<td>2 compartment sink</td>
<td>1 ½”</td>
<td>2</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>2”</td>
<td>4</td>
</tr>
<tr>
<td>Garbage Grinder</td>
<td>2”</td>
<td>4</td>
</tr>
<tr>
<td>Work Stove</td>
<td>2”</td>
<td>4</td>
</tr>
<tr>
<td>Floor Drains (2”, 3”, 4”)</td>
<td>2”, 3”, 4”</td>
<td>2, 3, 4 (1/2 credit)</td>
</tr>
<tr>
<td>*Floor Sinks (3”, 4”)</td>
<td>3”, 4”</td>
<td>3.4</td>
</tr>
<tr>
<td>Hand Sink</td>
<td>-</td>
<td>0*</td>
</tr>
<tr>
<td>Mop Sink</td>
<td>-</td>
<td>0*</td>
</tr>
</tbody>
</table>

*Note: Hand sinks and mop sinks are not required to be plumbed to the grease trap. For indirect waste to floor sinks and hub drains used as receptors for dishwashers, 2 and 3 compartment sinks, etc., the fixture unit count shall be two times (2x) the floor sink fixture count. Fixtures receiving non-grease bearing wastes may be drained through a trap, but shall not be included for the trap sizing.

B. Trap liquid holding capacity (gallons) = Total Fixture Count X Applicable retention time (minutes) X 3, as per City of Austin’s Industrial Waste Department requirements.

PART 3: EXECUTION

3.01 Pipe Applications - Above Ground, Within Building

A. Install hubless, service weight, cast-iron soil pipe and fittings for drainage and vent pipe.

3.02 Pipe Applications - Below Ground, Within Building:

A. Install hub-and-spigot, extra-heavy weight, cast-iron, soil pipe and fittings with gasketed joints for 15 inch and smaller drainage pipe.

3.03 Installation

A. Use fittings for all changes in direction and all branch connections.

B. Route exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

D. Route piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Allow sufficient space above removable ceiling panels to remove panel.

E. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals, such as Linkseal. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.
F. Fire Barrier Penetrations: Provide where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity.

G. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

H. Install underground building drains in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Provide underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Provide bell ends of piping facing upstream. Provide required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.

I. Install building drain pitched down at minimum slope of ¼ inch per foot (2 percent) for piping 4 inch and smaller and minimum 1/8 inch per foot (1 percent) for piping larger than 4 inches, unless approved otherwise by University project manager or University engineer. Provide sleeve and mechanical sleeve seal through foundation wall for watertight installation.

J. Provide 1-inch thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend a minimum of 12 inches beyond each side of pipe.

3.04 Installation of Piping Specialties

A. Do not install backwater valves in sanitary building drain piping.

B. Install expansion joints on vertical risers as indicated, and as required by the plumbing code.

C. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;

2. at each change in direction of piping greater than 45 degrees;

3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping.

4. at the base of each vertical soil or waste stack.

3.05 Installation of Floor Drains

A. Set drain grate depressed below finished slab elevation as listed below:

<table>
<thead>
<tr>
<th>DEPRESSION IN INCHES</th>
<th>RADIUS OF AREA DRAINED - FEET</th>
</tr>
</thead>
<tbody>
<tr>
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### 22 13 00 – FACILITY SANITARY SEWERAGE
#### DESIGN AND CONSTRUCTION STANDARD

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<thead>
<tr>
<th>Size</th>
<th>Rate</th>
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<tr>
<td>¾</td>
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END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section so that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:


1.03 Requirements:

A. “Fin Water” shall be defined as water that drips off the fins of cooling coils in the HVAC system. The term “condensate” refers to the steam system.
B. There are several types of recovered water at the University. Refer to Appendix 6.02.20 – Water Recovery and Re Use for detailed descriptions of each type.
C. Fin water shall be recovered and piped back to the central plant via the tunnel system.
D. When practical, storm water volumes shall be collected via a gutter or roof drainage system, retained, and reused for non-potable uses such as landscape irrigation.
E. Where perimeter drainage systems exist or where installed due to site drainage issues, the PSP shall evaluate the potential of perimeter drain water recovery. Such water shall be used for on-site irrigation or pumped back to the central plant via the tunnel system.

F. Oversize recovered water piping due to potential scaling issues. Provide a minimum 4” line from the pump discharge to the tunnel main connection.

G. Provide recovered water piping with steel sleeve where routed in footpath or in other exposed areas where piping could be damaged.

H. Provide pipe labels to say "Non-Potable", “Recovered Water”, and indicate direction of flow every 20 feet in the mains.

I. Provide shutoff valves (gate valves) at all sides of a tee connection and drain valves to allow for draining of each piping section.

J. All source connections should be hard-plumbed to prevent introduction of oil, solvents, trash, etc., into system.

PART 2: PRODUCTS

2.01 Piping:

A. Recovered water piping shall be schedule 80 PVC piping downstream of the recovered water pumps and in the tunnel system.

B. Provide steel sleeve on exposed recovered water piping routed in footpath and on any exposed piping within 4’ of finished floor.

2.02 Tanks:

A. Above ground, recovered water tanks shall be galvanized steel and drainable. Pumps should be Aurora Model 220 or approved equal with 1750 rpm motors prewired with a mechanical alternator. The receiver should have a sight glass and drain lines to a floor drain. There should be a 1 inch tee in the overflow piping to allow for a high-level alarm installation. There should be pump isolation valves between the tank and the pumps. See Appendix 6.02.20: Water Recovery and Re-Use for information on pump sizing. If a receiver is used, the receiver should have a sight glass and drain lines to a floor drain. There should be a 1” tee in the overflow piping to allow for a high-level alarm installation. There should be pump isolation valves between the tank and the pumps. Underground sumps can be polyethylene or fiberglass tanks suitable for underground installations.

B. Provide with inlet screens to prevent debris from entering tank. Provide with automatic overflow drainage to prevent water from backing up in system.
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design for new construction and renovations. The responsibility of the engineer is to apply the principles of this section and the ones that follow such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University, via the UT Project Manager, for approval.

B. All new construction and renovation involving plumbing fixture and emergency equipment installation shall meet requirements of the currently adopted revisions of the following standards and guidelines.

1. ANSI A117.1 Standard on Accessible and Usable Buildings and Facilities
2. ANSI Z124.2 Standard for Plastic Shower Head
3. ASSE 1016 Pressure Balancing Shower Valves
4. ANSI A112.18 Chrome Plated Brass Shower Head
5. ANSI Z358.1 Standard for Emergency Eyewash and Shower Equipment
7. State of Texas Accessibility Standards (TAS)
8. Americans with Disabilities Act (ADA)

C. Compliance with specified ANSI, UL, ASSE, State of Texas Accessibility Standards (TAS), and ASHRAE Standards will be required, as appropriate, for the installation all plumbing fixtures and appurtenant devices. Certification of compliance should be available upon request.

1.02 Requirements:

A. All fixtures, fixture accessories, faucets, fittings, supply stops and similar devices shall be of identical (same) manufacturer unless otherwise indicated. The PSP shall specify fixtures that
meet the following requirements and is encouraged to specify fixtures that carry the WaterSense seal.

B. Select combinations of fixtures and trim and other components that are compatible.

C. Provide custodial closets with wall or floor mounted, floor sink with minimum 12 inch high sides and shall be located near a door.

D. Support all wall mounted urinals, water closets and drinking fountains with fixture carriers with legs and welded steel bearing plates for urinal and drinking fountains anchored to floor.

E. The plumbing fixtures and appurtenant devices listed below are selected to establish examples of design intent and to set a standard of quality. Equivalent products from other manufacturers may be available and may be submitted for approval. The PSP must closely review the features and performance parameters of any alternate fixtures against the fixtures specified herein.

F. According to the current edition of the ANSI Z358.1 standard, provide emergency eye wash or combination eye/face washer in each work area and lab and a drench hose face washer at each major sink (cup sinks excluded) where an individual is using and/or exposed to injurious or hazardous materials. Minimum flushing flow rate for eye and eye face wash shall be 0.4 gpm for 15 minutes and the minimum flushing flow rate for a drench hose shall be 3.0 gpm for 15 minutes. Provide a minimum flow pressure at 35 psi and 30 psi residual flowing, maximum static pressure at 80 psi, water temperature range at 60 degrees to 95 degrees F.

G. Provide emergency deluge stations in corridors serving several research labs. Provide deluge stations near the entry to all teaching labs. Provide floor drains with deep seal traps and trap primers at each deluge station. Emergency deluge stations will have pull chain activation, unless directed otherwise.

H. Consult the most current edition of the Maximum Performance (MaP) Testing of Popular Toilet Models report in order to select the most efficient manufacturer and model available. Toilet models ranked according to MaP score with highest score given preference for selection for installation. The MaP report is published through the internet and is available free-of-charge on the websites of the Alliance for Water Efficiency (AWE) or the Canadian Water and Wastewater Association (CWWA) or the California Urban Water Conservation Council (CUWCC). MaP testing results for additional toilet models not included in the main report may be found by contacting the above organizations.

I. For renovations and new construction, provide with Manufacturers’ certified flows for fixtures as indicated below.

<table>
<thead>
<tr>
<th>Fixture Type</th>
<th>Maximum Certified Flow* (Ref. Note)</th>
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</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>1.28 gpf</td>
</tr>
<tr>
<td>Urinals (Standard)</td>
<td>0.5 gpf</td>
</tr>
<tr>
<td>Urinals (HEU), (Ref. Note)</td>
<td>No greater than 0.25 gpf</td>
</tr>
<tr>
<td>Showerheads</td>
<td>2.0 gpm</td>
</tr>
<tr>
<td>Kitchen Sink</td>
<td>1.5 gpm</td>
</tr>
<tr>
<td>Bath Lav</td>
<td>0.5 gpm</td>
</tr>
</tbody>
</table>
Commercial Lav 0.5 gpm

*(gpm = gallons per minute; gpf = gallons per flush)

J. Minimum pressure and flushing flow rate requirements for low flow flush-valve type fixtures (water closets, urinals, etc.): Provide minimum supply of 25 gpm at each fixture. Provide a minimum flow pressure at 35 psi and 30 psi residual (flowing), maximum static pressure at 80 psi. Design engineer is required to verify the adequacy of the water pressure using water supply data from the City of Austin distribution system and flow testing at new or existing building systems.

Note: High-Efficiency Urinals (HEUs) which use .25 gpf or less should be considered for LEED and/or as required for new University of Texas and State buildings and for major renovation projects at or greater than 2 million dollars per State Energy Conservation Office Water Efficiency Standards (SECO). All plumbing fixtures intended for use at the University of Texas shall also comply with the minimum standards as scheduled above in section 1.02/I and the State of Texas Health and Safety Code Section Title 5-B Chapter 372 Amended 9/1/2009.

PART 2: PRODUCTS

2.01 Plumbing Fixture Specifications

A. Comply with applicable standards below and other requirements specified.


2. Stainless-Steel Fixtures Other than Service Sinks: ASME A112.19.3M.

3. Vitreous-China Fixtures: ASME A112.19.2M.


5. ANSI 2124.2

6. ANSI A117.1

7. Texas Accessibility Standards (TAS)

8. ASSE 1016 Shower Valves

9. ANSI A112.18 Shower Heads

2.02 Miscellaneous Fitting Specifications

A. Comply with ASME A112.18.1M and other requirements specified for fittings, other than faucets. Include polished, chrome-plated finish, except where otherwise indicated. Coordinate fittings with other components and connectors.


3. Brass and Copper, Supplies and Tubular Brass: ASME A112.18.1M.


2.03 Miscellaneous Component Specifications

A. Comply with applicable Specifications below and other requirements specified for components for plumbing fixtures, equipment, and appliances.


3. Supports: ASME A112.6.1M.

2.04 Miscellaneous Materials

A. Copper Piping:

1. Pipe Size 2" and Smaller:
   a. Copper tube; Type "L", hard-drawn wrought-copper fittings, solder-joints. Use Dutch Boy or Silvabrite 100 lead-free solder, Composition 95/5, Solder Filler Metals: ASTM B 32, Solder containing lead is not permitted.
   b. Copper Tube; Type "L" with copper Press Fittings with rubber O-rings made with hydraulic compression tool, Viega ProPress or approved equal.
   c. Piping smaller than ¾” shall not be allowed.

2. Pipe Size 2 1/2 and Larger:
   a. Copper tube; Type "K", hard-drawn wrought-copper fittings, brazed sil-fos-joints manufactured by Sil-fos, Solder Filler Metals: Solder containing lead is not permitted.
   b. Copper Tube 2-1/2 to 4”; Type "K", with copper Press Fittings with rubber O-rings and stainless steel grip ring made with hydraulic compression tool, Viega ProPress or approved equal.

B. Exposed Connections

1. Provide chrome-plated solid brass ¼ turn ball valves, fittings, nipples, escutcheons, etc. for all exposed plumbing connections. Provide chrome-plated sleeves where existing exposed nipples must be re-used, so that all exposed parts have new chrome finish

2.05 Fixtures:

A. The plumbing fixtures listed in the Articles below are selected to establish examples of design intent and to set a standard of quality and meet water use standards. Equivalent products from other manufacturers may be available and may be submitted for approval. The PSP must
closely review the features and performance parameters of any alternate fixtures against the fixtures specified herein.

B. Water Closet WC-1 (ADA and Standard) HET 1.28 GPF: Wall-Hung Top-Spud Flush-Valve Type (ADA when mounted in raised position): Where plumbing fixtures of this designation are indicated, provide products complying with the following:

1. Manufacturers: Provide products by the following:
   c. Flush Valve FV-2 Piston type (Automatic with hardwired sensor) 1.28 gpf: Sloan Optima, Crown, and Zurn Metroflush.


3. Bowl Type and Operation: Elongated

4. Mounting and Outlet: Wall Hung, wall outlet supported with fixture carrier.

5. Fixture Bolt Caps: Metal with protective flat washer.

6. Rim Height: Standard: 15” inches., Handicapped: 17” inches

7. Flushometer Valve Construction: Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker.

8. Flushometer Valve Operation: Piston. (Manual or Automatic)


10. Flushometer Valve, Water Consumption: Factory set or field adjusted 1.28 gal. maximum per flushing cycle.

11. Manual Flushometer valve components include the following:
   a. Brass, lever-handle actuation
   b. Nonhold-open feature.

12. Toilet Seat: Solid-plastic, water-closet seat with bumpers and hardware, compatible with water closet and as follows:
   b. Class: Commercial, Standard.
c. Size: Elongated.

d. Pattern: Open front without cover or same as existing.

e. Hinge Type: Check (CK).

f. Provide with anti-microbial agent formed into the plastic.

C. Water Closet WC-2 (ADA or Standard) 1.28 GPF: Floor Mounted Top-Spud Flush-Valve
Type: Where plumbing fixtures of this designation are indicated, provide products complying
with the following:

1. Manufacturers: Provide products Manufactured by the following:

   a. Water Closet: (ADA or Standard), Toto, Crane, American Standard, Zurn and Kohler.

   b. Flush Valve FV-1 Piston type (Manual) 1.28 gpf Toto, Sloan, Crown, Zurn
      Metroflush, Kohler, and American Standard Flowise.

   c. Flush Valve FV-2 Piston type (Automatic with hardwired sensor) 1.28 gpf: Sloan,
      Optima, Crown, and Zurn Metroflush.


3. Bowl Type and Operation: Elongated

4. Mounting and Outlet: Floor mounted, floor outlet with closet flange and seal.

5. Fixture Bolt Caps: White, plastic or china.

6. Standard Seat Height 16” inches, Handicapped: Top of seat minimum 17” and 19”
   maximum.

7. Flushometer Valve Construction: Cast-brass body, brass or copper pipe or tubing inlet with
   wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker.


10. Flush meter Valve, Water Consumption: Factory set or field adjusted 1.28 gal. maximum
    per flushing cycle.

11. Manual Flushometer valve components include the following:

    a. Brass, lever-handle actuation.

    b. Nonhold-open feature.
12. Toilet Seat: Solid-plastic, water-closet seat with bumpers and hardware, compatible with water closet and as follows:
   
   
   b. Class: Commercial, Standard.
   
   c. Size: Elongated.
   
   d. Pattern: Open front without cover or same as existing.
   
   e. Hinge Type: Check (CK).
   
   f. Provide with anti-microbial agent formed into the plastic.

D. Water Closet WC-3 Floor Mounted (Pressure Assisted Tank Type): Where plumbing fixtures of this designation are indicated, provide products complying with the following:

1. Manufacturers: Provide products manufactured by the following:

   a. Water Closet (Floor Discharge, ADA or Standard): Mansfield, Gerber, Crane, Kohler, Zurn and Gerber.

   b. Pressure Assist Flushing Mechanism: Sloan Flushmate IV or Equal, Water Sense labeled.


3. Bowl Type and Operation: Elongated.

4. Mounting and Outlet: Floor mounted Bottom outlet with floor flange and ring seal.

5. Fixture Bolt Caps: White, plastic or china.

6. Standard Seat Height 16” inches, Handicapped: Top of seat minimum 17” and 19” maximum.

7. Pressure assist mechanism water consumption: Factory set or field adjusted, 1.28 gal. maximum per flushing cycle or less.

8. Toilet Seat: Solid-plastic, water-closet seat with bumpers and hardware, compatible with water closet and as follows:


   b. Class: Commercial, Standard.

   c. Size: Elongated.

   d. Pattern: Open front without cover.
e. Hinge Type: Check (CK).

f. Provide with anti-microbial agent formed into the plastic.

E. Water Closet WC-4 Floor Mounted (Tank Type minimum class-6): Where plumbing fixtures of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance with the City of Austin Rebate program requirements where applicable, provide products Manufactured by the following:


   b. Gravity Flushing Mechanism.


3. Bowl Type and Operation: Elongated.

4. Mounting and Outlet: Floor mounted Bottom outlet with floor flange and ring seal.

5. Fixture Bolt Caps: White, plastic or china.

6. Standard Seat Height 16” inches, Handicapped: Top of seat minimum 17” and 19” maximum.

7. 1.28 gal. maximum per flushing cycle or less.

8. Toilet Seat: Solid-plastic, water-closet seat with bumpers and hardware, compatible with water closet and as follows:


   b. Size: Elongated.

   c. Pattern: Open front without cover.

   d. Hinge Type: Check (CK).

F. Provide with anti-microbial agent formed into the plastic Urinal (UR-1): (ADA and Standard) HEU 0.5 GPF: Wall-Hung Top-Spud Flush Valve Type (ADA when mounted in lowered position) Washout Action minimum 17”X26” body. Where plumbing fixtures of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance provide products by the following:


c. Flush Valve FV-4 Piston type (Automatic with hardwired sensor) 0.5 gpf: Zurn MetroFlush and Sloan Optima Crown.


3. Flushometer Valve Construction: Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker.


5. Flushometer Valve Finish: Polished, chrome-plated, exposed metal parts.

6. Flushometer Valve, Water Consumption: Factory set or field adjusted 0.5 gal. maximum per flushing cycle.

7. Flushometer valve components include the following:
   a. Brass, lever-handle actuation.
   b. Nonhold-open feature.

G. Urinal (UR-2): (ADA and Standard) HEU no greater than 0.25 gpf: Wall-Hung Top-Spud Flush Valve Type (ADA when mounted in lowered position) Washout Action minimum 17”X26” body. Where plumbing fixtures of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance provide products by the following:
   b. Flush Valve FV-5 Piston type (Manual) no greater than 0.25 gpf, Kohler, Zurn and American Standard Flowise.


3. Flushometer Valve Construction: Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker.


5. Flushometer Valve Finish: Polished, chrome-plated, exposed metal parts.

6. Flushometer Valve, Water Consumption: Factory set or field adjusted no greater than 0.25 gal. per flushing cycle.

7. Flushometer valve components include the following:
   a. Brass, lever-handle actuation.
b. Nonhold-open feature.

H. ADA and Standard Lavatory (LAV-1): Wall mounted 20”W x 18”D vitreous china lavatory, with rectangular basin and minimum 4” high backsplash, splash lip, front overflow, fabricated for concealed arm supports, and having two soap depressions. Drill lavatories for 4” center faucets. Provide concealed arm carriers, “Type-A or B” faucet (section 2.06), trap, copper chrome plated supplies, angle ¼ turn ball valves and vinyl covers as specified in the Articles below, (section 2.10). Use products by Manufacturers listed or an approved equivalent, Toto, Crane, Zurn, American Standard and Kohler.

I. ADA and Standard Lavatory (LAV-2): Self-rimming counter top mounted 20” x 17”, Oval vitreous china lavatory, and front overflow. Drill lavatories for 4” center faucets. “Type-A or B” faucet, (Section 2.06), trap, supplies, angle valves and vinyl covers as specified in (Section 2.10). Use products by Manufacturers listed or an approved equivalent, Toto, Crane, Zurn, American Standard and Kohler.

J. ADA Stainless Steel Sinks (SK-1): 25”L x 21”W x 5-1/2” Deep Single bowl, 20 gauge type 304 Stainless Steel, self-rimming, single compartment sink, drain opening located off centered rear of sink bowl with standard (3) faucet holes for 8” on center set “Type-C” faucet as specified in (section 2.06). Basket strainer w/ rubber stopper and 1-1/2” Brass chrome plated tailpiece. Trap, supplies and stops as specified in (Section 2.10).

K. Service Sink (SS-1): 24” x 20”x 12” deep bowl minimum, acid-resisting eameled inside, cast iron service sink with back wall hanger and with stainless steel rim guard and 10” backsplash. Provide complete with service sink 3” cast iron adjustable trap standard to wall with floor support and cleanout plug, having acid resisting enamel finish inside, painted outside, with strainer, and outlet for 3” cast iron pipe. Provide "Type-D" faucet as specified in (section 2.06).

L. Service Sink (SS-2): (Mop Basins) 36” x 24” Molded Stone floor mounted sink with 12” minimum high walls with aluminum bumper guard, wall guard. Provide 3” stainless steel flat grid strainer. Provide Type-D" faucet as specified in (Section 2.06).

M. Emergency Showers (ES-1): (Ceiling or floor mounted), emergency, drench type, having 10” diameter stainless steel deluge shower head, 1”-1/4” I.P.S. cold water rough, provide a minimum pressure of 30 psi, chrome plated. Instant-action, stay-open brass ball valve that stays open until manually closed, activated by rigid stainless steel pull rod with triangular handle. Provide with audible alarm (preferably bell) to sound upon detection of flow. Floor mounted type supported by 1-1/4” steel pipe pedestal with 9” diameter floor flange. Units (Ceiling or floor mounted) shall be mounted to meet all ADA barrier free requirements. Unit shall be provided with waste receptor (floor drain) piped to sanitary sewer, provide Trap Guard trap seal protection device or engineered equal.

N. Emergency Eyewash Fountains (EW-1): (Wall or floor mounted), stainless steel receptor with integral wall mounting bracket or 1-1/4” steel pipe pedestal with floor flange. Unit shall have wrap-around spray head with hinged dust cover with positive link actuation (push flag and or foot actuation). 3/4” I.P.S. cold water rough provide a minimum pressure of 30 psi. Instant action stay open brass ball valve that stays open until manually closed; pressure compensated stream control and chrome plated strainer and 1-1/4” tailpiece piped to sanitary waste. Wall mounted type to be provided complete with trap. Units (Ceiling or floor mounted) shall be
mounted to meet all ADA barrier free requirements, provide Trap Guard trap seal protection device or engineered equal.

O. Emergency Shower & Eyewash Fountain Combination (ES/EW-1): (Shower), Floor mounted emergency, drench type, having 10" diameter stainless steel deluge shower head, 1"-1/4" I.P.S. cold water rough, provide a minimum pressure of 30 psi, chrome plated instant action stay open brass ball valve that stays open until manually closed, activated by rigid stainless steel pull rod with and triangular handle. Floor mounted and supported by 1-1/4” steel pipe pedestal with 9” diameter floor flange. (Eyewash), Stainless steel receptor with 1-1/4” steel pipe outlet connected to emergency shower steel pipe pedestal with outlet connected to sanitary waste. Unit shall have wrap-around spray head with hinged dust cover with positive link actuation (push flag and or foot actuation). Provide with audible alarm (preferably bell) to sound upon detection of flow. Instant action stay open brass ball valve that stays open until manually closed; pressure compensated stream control and chrome plated strainer and 1-1/4” tailpiece. Unit shall be mounted to meet all ADA barrier free requirements. Unit shall be provided with waste receptor (floor drain) piped to sanitary sewer, provide Trap Guard trap seal protection device or engineered equal.

P. Soap Dispensers: For counter mounted sinks provide dispenser with pump type deck mounted valve, 4” 316 stainless steel spout 316 stainless steel plunger activated with less than 5 lbs. force, 4-3/4” shank shall accommodate 3-1/2” mounting thickness with 32 oz. Polyethylene tank globe. For wall mounted installation above sinks, provide a manual push dispenser for one handed use, metered foam spray manufactured by Technical Concepts Model 450017.

Q. Electric Water Cooler, Wall Mounted (ADA Compliant Mounted): (Single and two-level units). Units shall be factory assembled and tested, listed and labeled in compliance with UL Standard 399, and have capacities rated in accordance with ASHRAE Standard 18, ARI Standard 1010 and ANSI/NSF61, Section 9-1997B. All units shall be lead-free design, standard color with stainless steel basin, easy touch controls front and side with apron attached to high unit if designated by TAS/ADA as a protruding object. 8 GPH capacity with one refrigeration unit to serve two-level units, as manufactured by Elkay, Models EZSTLR8C high unit on right or EZSTL8C high unit on left. Single unit, Elkay Model EZS8.

R. Hose Bibs Toilet Rooms (HB-1): Inside sill faucet, polished chrome plated brass, vacuum breaker, 3/4” hose thread outlet mounted at 22” above finished floor, removable tee handle, 3/4” female inlet with escutcheon (flanged), Chicago Faucets NO. 952.

S. Wash Down Hose Station (WS-1): For Hot and cold water service, thermostatically controlled mixing valve with dial-in temperature setting, temperature limit stop and temperature gauge. For hot and cold water service provide (cast bronze ball valves with inline check valves, unions). Water gun with 50 ft. high pressure hose with swivel connection fitting and stainless steel hose rack Manufactured by Strahman, Inc., Model M-200-TS-Y with 21S Swivel and 150 Spray Nozzle.

2.06 Faucets:

A. Faucet (Type-A): ADA Compliant manual faucet. Polished chrome plated cast brass, 4" center set, 4" spout with chrome-plated pressure compensating vandal resistant 0.5 GPM aerator, single-wing ADA handles indexed "HOT" and "COLD", Provide supplies, angle valves, vinyl covers and 1-1/2” waste with grid drain strainer as specified in (Section 2.10).
1. When new construction or renovation of plumbing fixtures of this designation are indicated, use products by Manufacturers’ listed below or an approved equivalent (subject to compliance with requirements).

   a. Chicago Faucet 802-317CP – dual lever with Quaturn repairable disc.

2. For new construction and renovations, all installed faucets shall include ADA compliant 4 inch wrist paddles.

B. Faucet (Type-B): ADA Compliant electronic 120VAC/6-24 VAC sensor operated hand wash faucet for tempered hot and cold water with below sink mounted control module or concealed internal to faucet. Polished chrome plated cast brass, 4" center set trim plate, and 5" spout with chrome-plated, pressure compensating vandal-resistant 0.5 GPM aerator. 120 VAC/6-24 VAC 50/60 Hz. box mounted transformer (Sized to operate total number of faucets used and located maximum 50 ft. from furthest faucet, each solenoid valve requires 15VA each). All electrical wiring from transformer to control module is to be routed in metal conduit. Provide below sink or concealed internal to faucet. Thermostatic mixing control valve for water temperature control, balanced water temperature to a maximum temperature of 120°F. Provide supplies, angle valves, grid drain strainer, trap and vinyl covers over supplies and drain specified in section 2.10.

C. Faucet (Type-C): Kitchen Sink Faucet ADA Compliant manual 8” spout x 12” high Goose Neck swing spout faucet. Polished chrome plated cast brass, 8" center set, spout with chrome plated pressure compensating vandal resistant 1.5 GPM aerator, single-wing ADA handles indexed "HOT" and "COLD". Provide supplies, angle valves, grid drain strainer and vinyl covers specified in section 2.10.

1. When new construction or renovation of plumbing fixtures of this designation are indicated, use products by Manufacturers’ listed below or an approved equivalent (subject to compliance with requirements).

   a. Chicago Faucet 201-AGN-317CP – dual lever with Quaturn repairable disc.

D. Faucet (Type-D): Service Sink faucet (Fixture back or Wall Mounted) Chrome plated cast brass; 8" center set, spout with vacuum breaker, hose thread, bucket hook spout and supported with adjustable wall bracket. Faucet handles indexed "HOT" and "COLD". Provide 30” hose and wall hose bracket.

E. ADA Compliant Shower (Type E): Wheelchair ADA Compliant Shower Faucet (Individual Shower Unit) SH-1: Pre-assembled chrome plated brass fittings, with (1) heavy commercial shower head wall mounted and (1) accessible hand held spray shower unit with 60” inch Stainless steel flexible hose with inline backflow preventer (vacuum breaker) and mounting post attached to 30” inch slide bar mounted on wall and diverter valve with cast brass body and cast brass chrome plated lever handle. Unit shall deliver Maximum of 2.0 gpm including the following:

1. Shower Valve for Hot/Tempered and Cold Supply: Heavy-duty pressure balancing thermostatic type with anti-scald limit stops mixing type shower valve with stainless steel piston and cartridge, 1/2” chrome plated brass stem, tamper resistant brass limit stop, vandal resistant single blade (ADA) and (TAS) compliant level handle; chrome
2. Shower Head: Cone spray, heavy commercial chrome plated solid brass body, vandal proof, and t-handle volume control and ball joint movement.

3. Accessible (ADA) and (TAS) compliant Unit: Hand held spray shower unit with 60 inch stainless steel flexible hose with inline backflow preventer (vacuum breaker) and mounting post attached to 30” inch slide bar mounted on wall and diverter valve with cast brass body and cast brass chrome plated lever handle.


F. Shower (Type F): Shower Faucet (Individual Shower Unit) SH-2: Pre-assembled chrome plated brass fittings, with heavy commercial shower head wall mounted. Unit shall deliver Maximum of 2.0 gpm including the following:

1. Shower Valve for Hot/Tempered and Cold Supply: Heavy-duty pressure balancing thermostatic type with anti-scald limit stops, mixing type shower valve with stainless steel piston and cartridge, 1/2” chrome plated brass stem, tamper resistant brass limit stop, vandal resistant single blade level handle, chrome plated brass cap, ASSE-certified hot water limit screw, and integral check stops on inlets.

2. Shower Head: Cone spray, heavy commercial chrome plated solid brass body, vandal proof, and t-handle volume control and ball joint movement.


G. Faucet repair or replacement Aerators shall be as listed below: New faucets shall be provided with manufactured supplied vandal resistant aerators complying with certified flows for fixtures as indicated in Standard 5.22.40 Section 1.02/K.

1. Manufacturers:
   
   a. Neoperl High-Efficiency PCA spray (Vandal resistant)

   b. Niagara High-Efficiency (Vandal resistant)

2. Water Consumption: 0.5 and 1.5, gallon maximum per minute as specified for each location.

3. Dual threaded: coordinate threads of existing faucet to be retrofit and provide model with compatible threads.

4. Spray and laminar flow type as indicated.

H. Shower Head Replacements shall be as listed below: New Showers shall be provided with manufactured supplied shower head complying with certified flows for fixtures as indicated in Standard 5.22.40 - Section 1.02/I.

1. Manufacturers:
a. Niagara High-Efficiency showerhead N2920CH or approved equal.

2.07 Flush Valves:


B. Flush Valve (FV-2): Automatic for (HET Water Closet 1.28 GPF) electronic sensor operated, exposed, hard wired, 6-24 VAC integral solenoid operated exposed flush valve with solenoid electrical box cover plate, infrared sensor with electric box and cover plate, 120 VAC / 6-24 VAC (50 VA) class II UL listed J-Box mount, multiple flush valve transformer (max. of 8 closet / urinal flush valves, coordinate with manufactures recommendations), chrome plated, 1" I.P.S. screw driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, vacuum breaker flush connection and spud coupling for 1-1/2" top spud flanges. Manufacturers: Sloan Optima Crown and Zurn Metroflush.


D. Flush Valve (FV-4): Automatic electronic sensor operated exposed, 24 VAC integral solenoid operated exposed flush valve for (HEU Urinal 0.5 GPF) with solenoid electrical box and cover plate with integrated infrared sensor, 120 VAC / 6-24 VAC (50 VA) class II UL listed J-Box mount, multiple flush valve transformer (max. of 8 or 10 closet / urinal Flush valves coordinate with manufactures recommendations). Requires a chrome-plated, 3/4" I.P.S. screw driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, vacuum breaker flush connection and spud coupling for 3/4" top spud flanges 0.5 gpf. Manufacturers: Sloan Optima Crown and Zurn Metroflush.

E. Flush Valve (FV-5): Manual Fixed volume Piston Type exposed closet flush valve for (HEU Urinal no greater than 0.25 GPF), chrome plated, metal oscillation non-hold-open handle, 3/4" I.P.S. Screw Driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, vacuum breaker flush connection and spud coupling for 3/4" top spud flanges, Mount ADA compliant flush valve handle to wide side of Toilet room within partitions. Manufacturers: Kohler, Zurn and American Standard Flowise.

Note: Only (1) transformer is required for the maximum total of 8 or 10 water closets and/or urinals in each toilet room, coordinate installation with manufactures recommendations. (Size transformer to operate total number of flush valves used and locate maximum 50 ft. from furthest flush valve), All electrical wiring from transformer to control module to solenoid valve shall be routed in metal conduit. Mount sensor on wide side of toilet stall, if no stall is
incorporated, install to wide side of open area within room. Manufacturers: Sloan Optima (Piston), Zurn Metroflush (Piston).

2.08 Commissioning and Cleaning Electronic Flush Valves:

A. Sensor Operated Flush Valves:

1. Mount 120 VAC / 6 VDC-24VDC power converters and distribution panel in NEMA-1 electrical enclosure mounted in plumbing chase wall, cover enclosure with stainless steel access panel, label access panel (power converter). Furnish and install one power converter and distribution panel for each set of (men’s and women’s) toilet rooms, (max. of 8 water closet / urinal flush valves total for each power converter). Reference and show location on plumbing plans. Install as recommended by flush valve manufacturer.

B. Cleaning:

1. Flush all new and existing potable water systems from the connection to the main risers to each individual fixture. Flush with clean potable water. Systems shall be flushed prior to disinfecting systems and prior to the installation of new faucets and flush valves. Flushing shall be observed by University of Texas inspector.

C. Commissioning:

1. Each automatic flush valve shall be commissioned in order to achieve a “passing” status. Make all adjustments and troubleshoot as per manufacturers recommendations. Demonstrate proper operation including sensor control and sensor delay. Training shall include a minimum of four (4) hours by authorized manufacturer’s representative. The commissioning procedure listed below in Section D. is to be used as a sample guide. Installer shall provide a commissioning plan and test procedure for automatic flush valves per the specific manufacturer’s recommendations.

D. Prepare and Test each Flush Valve as Follows:

1. Flush out the supply line. Make sure the control stop is closed. Remove Flushometer cover. Lift out the trip mechanism. Install the Flushometer cover wrench tight and open control stop. Turn on water supply to flush line of any debris or sediment. After completion, shut off the control stop, remove cover and reinstall the trip. Install Flush meter cover wrench tight. Water flushes for the correct duration.

   \[\text{DONE} \quad \underline{_______}\]
   \[\text{NOT DONE} \quad \underline{_______}\]

2. Adjusting the control stop. Open control stop full open. Activate Flush meter simulating a user. Adjust the control stop only to prevent splashing. Installer to consult with owner/engineer prior to reducing water flow to any fixture.

   \[\text{DONE} \quad \underline{_______}\]
3. The switch settings for the flush valve's controller are as follows (left is on, right is off):
   Switch 1 - Automatic Flush - OFF
   Switch 2 - Red/Green LED - ON
   Switch 3 - Courtesy Flush – OFF
   DONE ________
   NOT DONE ________

4. Sensor's Red/Green LED is functional. The red light illuminates when an object is detected. The green light illuminates after the object has been detected for a period of 8 seconds then leaves. The green light indicates the flushing sequence.
   PASS ________
   FAIL ________

5. Sensor's range adjustment is correct. Flushing should occur when object is detected within 30" of sensor. Make range adjustments by turning adjustment screw CW to increase range, and CCW to decrease range. Caution: range adjustment rotates only ½ turn min. to max. Do not exceed.
   PASS ________
   FAIL ________

6. Controller's override button is functional. Upon manually activating override button, valve automatically flushes for proper duration. (Feature is provided at water closets).
   PASS ________
   FAIL ________

7. Controller's maintenance override feature is functional. The sensor may be disabled for 10 minutes by placing a magnet on sensor lens for 3 to 5 seconds. After 10 minutes the sensor will automatically resume functioning.
   PASS ________
   FAIL ________

2.09 Fixtures Supports:

A. Lavatory Supports: Cast iron supports, having tubular steel uprights with welded base and concealed arms and sleeves, mounted on adjustable headers with escutcheons, and complete with heavy cast iron short feet, alignment trusses, and mounting fasteners.

B. Water Closet Supports: Adjustable, factory painted, cast iron face plate, support base, and appropriate type waste fitting having face plate gasket; coated steel fixture studs and fasteners; coated and threaded adjustable wall coupling face plate with neoprene closet outlet gasket; and chrome plated fixture cap nuts and fiber fixture washers. Provide an appropriate model to suit deep or shallow rough-in for siphon jet water closet, and type of sanitary piping system to which it is connected. Universal floor mount foot supports with rear anchor tie down.
C. ADA Water Closet Supports: Adjustable, factory painted, cast iron face plate, support base, and appropriate type waste fitting having face plate gasket; coated steel fixture studs and fasteners; coated and threaded adjustable wall coupling face plate with neoprene closet outlet gasket; and chrome plated fixture cap nuts and fiber fixture washers. Units shall have elevated mounting heights of ADA fixtures for siphon jet water closet, and type of sanitary piping system to which it is connected. Universal floor mount foot supports with rear anchor tie down.

D. Urinal Supports: Concealed wall supports for urinals shall have steel top and bottom support bearing plates with bolts to support fixture independently from the wall; coated rectangular steel uprights with welded feet, adjustable support plates, and fasteners.

E. Water Cooler Supports: Concealed wall supports for water cooler shall have steel top and bottom support bearing plates with bolts to support fixture independently from the wall; coated rectangular steel uprights with welded feet, adjustable support plates, and fasteners.

2.10 Fittings, Trim, and Accessories:

A. Toilet Seats: Elongated, solid white plastic closed back/open front, less cover, and having stainless steel check hinge and replaceable bumpers. All toilet seats to be anti-microbial type.

B. Supplies and Stops for Lavatories and Sinks: Polished chrome-plated, loose-keyed heavy commercial ¼ turn ball angle stop with wall flange (Escutcheon) having 1/2” inlet and 3/8" O.D. x 12" long flexible supply riser tubing outlet and brass chrome-plated escutcheon.

C. Supplies and Stops for Tank Type Water Closets: Polished chrome-plated loose-keyed heavy commercial ¼ turn ball angle stop with wall flange (Escutcheon) having 1/2” inlet and 1/2” O.D. x 12" long flexible supply riser tubing outlet with collar, and escutcheon.

D. Traps for Lavatories: Chrome plated Cast brass 17 GA., 1-1/2” adjustable "P" trap with cleanout and waste to wall, 1-1/2” tailpiece with grid strainer.

E. Traps for Sinks: Chrome plated Cast brass 20 GA., 1-1/2” adjustable "P" trap with cleanout and waste to wall, brass basket strainer and tail piece with brass stopper.

F. ADA Trap Covers: Molded resilient vinyl lavatory p-trap and angle valve antimicrobial insulation covers secured with snap-clip flush fasteners.

G. Tub Waste and Overflow Fittings: Concealed lever operated pop-up bath waste and overflow; chrome plated waste spud with universal type outlet connection suitable for 1-1/2" I.P.S., or 1-1/2" O.D. tubing, or 1-1/2" solder-joint outlet connection on waste tee.

H. Escutcheons: Chrome-plated cast brass with set screw.

PART 3: EXECUTION

3.01 Installation:

A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers’ written instructions.
B. Install fixtures level and plumb according to manufacturers’ written instructions, rough in drawings, and referenced Specifications.

C. Provide stop valves in an accessible location in the water connections to each fixture.

D. Provide escutcheons at each wall, floor, and ceiling penetration in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

E. Seal joints between fixtures and adjoining walls, floors, and counters using sanitary-type, 1-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Grout shall/may be used on floor mount toilets where the existing floor is concrete.

F. Install traps on fixture outlets. Omit external traps on fixtures and equipment having integral traps. Omit traps on indirect waste drain lines, except where otherwise indicated. Indirect waste from sanitary sewer shall be trapped and vented.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 Codes and Standards

A. Plumbing Code Compliance: Comply with applicable portions of International Plumbing Code pertaining to selection and installation of plumbing materials and products. Design shall conform to the Uniform Plumbing Code requirements where interaction occurs with City of Austin utilities or infrastructure.

1.03 Requirements

A. The UT-Austin campus has a central system for distribution of de-ionized water which is referred to as lab water. (For historical reasons, it is often referred to as distilled water.) The Lab water is carried in pressurized PVC Schedule 80 lines in the utility tunnels and up to the building storage tanks.

B. The central reverse osmosis/demineralizer system is designed to produce water that meets the following quality specifications:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Quality Specification*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity</td>
<td>&lt; 15 microSiemens</td>
</tr>
<tr>
<td>pH</td>
<td>6.0 to 9.0</td>
</tr>
<tr>
<td>Nonvolatile TOC</td>
<td>&lt; 1.0 ppm</td>
</tr>
</tbody>
</table>

* Under normal operating conditions, conductivity is less than 0.5 micromhos/cm, and TOC is non-detectable (Practical Quantitative Limit of .5 ppm).

C. If project requirements demand water quality in excess of that listed above, provide supplemental point-of-use “polishing” systems necessary to provide a continuous supply of water that meets individual water purity requirements.

D. For buildings requiring DW, provide a 1” PVC 80 line from the tunnel DW main up to a non-pressurized DW tank in the attic. This supply line should have a stainless steel ball valve for isolation purposes with a tee and stainless steel drain ball valve located at the tunnel entrance. Provide a stainless-steel orifice in the line (1/4” for buildings with large DW demand, 1/8” for buildings with small demand) to limit the amount of makeup to the tank. Provide a valved bypass line around the orifice to allow expedited system refill after being drained.

E. Provide a stainless-steel solenoid valve to maintain the level in the DW tank. Provide a valved bypass line with stainless steel ball valves to bypass the solenoid and orifice. Provide a larger PVC line (often 2 inch) to allow DW flow by gravity or booster pump system from the tank to
the building uses. Booster pump systems shall be required to provide adequate pressure to upper floors and building areas with high volume demand equipment.

F. An ultraviolet sterilizer shall be installed in the piping downstream of the DW storage tank.

G. DW Storage tank shall be provided with tank level sight glass. Sight glass shall be piped external to tank and be provided with isolation service valves at top and bottom of glass. Sight glass shall be equipped with high and low level switches as well as high-high and low-low level alarm switches. Switches shall be located within the section of sight glass isolated by service valves. Switches shall provide dry contacts for reporting conditions to BAS/FCMS system.

H. Provide means of flushing DW system from each end of main system feed on each floor of building with access. New or modified systems shall be designed to incorporate the means to maintain the integrity of water quality to prevent any system contamination. Care shall also be taken to prevent contamination to materials stored or in transit. Any modifications to the system piping or equipment shall require prior notification and pre approval from UT Facilities Services. Design shall provide for future remodeling and incorporate the flexibility to accommodate future changes in research having minimal effect on adjacent labs and research programs and the means to maintain the integrity of water quality during any system modifications to prevent system contamination.

I. Provide each riser connection serving a building floor or area with section valves for isolation with access. Provide each branch connection to main feed serving a floor or area with section valves for isolation with access. Branch connections from main feeds shall be from top of header.

J. Provide de-ionized water piping loop to minimize “dead legs”. Dead legs over 12” shall not be allowed.

K. Provide circulation in all de-ionized water loops at three feet per second minimum, with a target pipe velocity of five feet per second.

PART 2: PRODUCTS

2.01 Standards for Basic Identification:

A. General: Piping identification Standard at the University is ANSI A13.1 "Scheme for Identification of Piping Systems. All piping shall have flow arrows indicating direction of flow.

2.02 Lab Water Piping, Valves and Fittings:

A. Pipe valves and fittings for purified water service shall be Schedule 80, Flame Retardant natural virgin, unpigmented Polypropylene or PVDF with socket thermo seal fusion fittings. The piping upstream of the tank should be schedule 80 PVC with stainless steel ball valves.

B. Installation practices, including support spacing and joint fusion, shall be in compliance with manufacturer's printed recommendations.
C. Materials from which pipe, fittings and valves are manufactured shall have been tested and approved for conveying potable water by the National Sanitation Foundation (NSF). All pipe, fittings and valves shall bear the NSF hallmark indicating that the material has been tested and approved for conveying lab water by the NSF.

D. To ensure installation uniformity, all system piping components shall be the products of one manufacturer.

E. All piping shall be thoroughly rinsed and flushed to remove all dirt and debris before installation. After installation the Contractor shall flush the entire piping system with de-ionized water to the satisfaction of the Owner.

F. All piping exposed within plenums shall have a smoke-developed index of no more than 50 and flame-spread index of no more than 25. All non-conforming piping material located in plenums shall be sleeved. Contractor shall provide a sleeved system through the installation of grooved Schedule 10 galvanized piping and couplings. The sleeve piping shall be no less than 2 inches greater diameter than the polypropylene piping contained within it. Only rolled groove piping may be used. The Victaulic "Fit" fittings and piping system, or any similar set screw type fitting system is specifically prohibited. Vic-Let and Vic-O-Well or similar type fittings are specifically prohibited for use in this application. Where a reduced tee fitting is required, then a reducing tee or regular tee with bell reducer shall be used. If any of the above described prohibited materials or installation methods are used, then the material or installation method shall be corrected at the contractor’s expense.

G. Valves shall be ball valve type and shall be manufactured of the same virgin, unpigmented molding compound as the fittings to assure compatibility.

H. All ball valves shall have Viton seals, and PTFE seats. Ball valves shall carry a pressure rating of 150 psi at a minimum of 68F, and shall be of True Union design.

2.03 Lab Water Pumps:

A. Pumps shall be heavy duty plastic or stainless steel duplex, centrifugal type.

B. Pump heads, sleeve and impeller shall be polypropylene or stainless steel. Seal shall be mechanical type.

C. Each pump shall be provided with a fused safety switch and a magnetic starter providing overload and under voltage protection. A mechanical alternator shall automatically alternate the operation of the pumps

D. Pumps shall be furnished completed with Vinton, or approved equal, suction and discharge pressure gauge isolator-activators to separate gauge from deionized water.

2.04 Level Controller:

A. Level controller shall be full plastic body type with no metal parts in contact with deionized water. Ultrasonic controllers are also approved.

2.05 Holding Tanks:
A. Furnish and install heavy duty plastic polypropylene or polyethylene tanks that are food grade or NSF rated.

B. Tanks shall be suitable for 75 psig pressure and 120 degree F. temperature.

C. Tanks shall be vertical cylindrical type, with dished or conical bottom. Tank overflow can be piped to the steam condensate system when possible or the recovered water system. Tank shall have a tight-fitting removable cover, a steel floor stand, an air filter capable of removing particles as small as 0.5 micron.

2.06 Flow Control Valves:

A. Provide a 3/8 inch PP flow control valve in each and every lab water outlet that limits the flow to 1/2 GPM. Provide a 2 GPM a natural, virgin, unpigmented polypropylene flow control valve in each de-ionized water connection to equipment.

B. Flow control valves shall maintain a constant flow regardless of inlet pressure changes between 15 and 100 psig. No metal shall be in contact with the liquid.

2.07 Pressure Regulating Valves:

A. Contractor shall supply and install, where shown on the drawings, socket fusion natural, virgin, unpigmented polypropylene pressure regulating valves.

B. Valves shall accurately reduce and regulate steady or varying inlet pressures and maintain a constant predetermined outlet pressure.

2.08 Pressure Gauges:

A. Pressure GAUGES shall be 2-1/2 inch diameter, dual calibrated for 0 to 100 psig and SI units, having 316 stainless steel bourdon tube. Provide gauges with inline dead-leg gauge guards where possible.

2.09 Purified Water Storage Tank:

A. Tank shall be vertical cylindrical type, stainless steel or FRP-jacketed polyethylene, with dished or conical bottom. Tank shall have a tight-fitting removable cover, a steel floor stand, an air filter capable of removing particles as small as 0.5 micron, and rounded interior corners. All tank penetrations shall be factory made. Stainless steel tanks shall be No. 4 finish; polyethylene tanks shall be made of FDA approved resin. Stainless steel tanks shall be No. 4 finish; polyethylene tanks shall be made of FDA approved resin.

2.10 Level Sensors:

A. Level sensors shall have only stainless steel and Viton in contact with the fluid. Each shall have a snap action switch rated for 125 volts, with an adjustable deadband initially set at 3 inches.

B. One level sensor shall be wired with the solenoid valve to automatically maintain the liquid level in the tank. The other is to be connected to the BAS system.
PART 3 EXECUTION

3.01 Installation:

A. At every floor penetration a cast in sleeve or other monolithic curbing at least 2 inches high shall be provided to help contain water spills or leaks.

B. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

END OF STANDARD
PART 1: GENERAL

1.01 General Requirements

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section and the ones that follow such that the University of Texas at Austin may achieve a level of quality and consistency in the mechanical design of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

B. Use UT Austin specifications and equipment schedule format for HVAC equipment where available.

C. Use UT Austin standard installation and construction details where available. Refer to Appendix for list of available standard CADD details.

D. Use UT Austin standardized HVAC control schematic and component parts where available. Refer to Appendix for list of available standard CADD control schematics.

E. Use gravity drain of liquids at all possible places. Recover all fin water sources to the extent of economic feasibility. Refer to 5.22.20 Water Recovery for further direction.

F. UT Austin preference for mounting of air handler temperature control valves is for serviceability from floor without the use of ladder; maximum height 5'0" AFF. Where service valves are mounted 8 feet above the floor provide service platform, catwalk, or Rotohammer chain wheels and safety-trimmed chains. Do not block equipment access when locating temperature control valves.

G. Indicate required service clearances on drawings with dashed lines. Design shall provide for service and maintenance access to all equipment. Service area shall comply with codes and manufacturer’s recommendations and shall be reasonably planned for human access. Project shall provide elevator access to all levels including basement and attic mechanical spaces. Elevators shall be sized and designed for equipment removal.

H. Design shall include plan for removal of all equipment. Plan shall indicate sizes of major pieces of equipment and clearly marked paths of removal and egress for this equipment from point of installed equipment-to-equipment loading area exterior to building. Entire egress path shall be coordinated for removal of equipment. Preference is to remove all equipment through elevators to ground level. Egress paths of equipment through removable louvers or roof cupolas are acceptable provided louver or cupolas locations are crane accessible. Coordinate with structural to add lifting beams as required to move or replace heavy equipment.

I. Include a 0-100 psi pressure gauge on the domestic water header. Also include an electronic pressure sensor on the header, suitable for connection to University BAS system.
J. Provide N+1 redundancy for equipment providing building utility service such as local chilled water pumps, heating hot water converters, and heating hot water pumps. N+1 redundancy shall also be provided for equipment serving critical applications such as laboratory exhaust fans.

K. Avoid 3-1/2 and 5-inch diameter pipe.

L. Mechanical systems shall be designed in accordance with the latest version of ASRHAE 90.1 adopted by the State Energy Conservation Office.

M. A detailed HVAC control sequence of operations and BAS point list shall be included in the plans and specifications.

1.02 Codes:

A. Refer to Section 4.01.02 Codes and Standards.

1.03 Mechanical Systems Selection:

A. Airside - HVAC
   1. Provide air handling units configured to serve campus buildings in accordance with these standards as minimum level and consistent with good engineering practice, zoned in a practical manner to facilitate convenient building operation, thermal performance and shutdown. Design HVAC systems with a practical number of air handling units preferably located to a common mechanical room to increase functional space within the building. The exact quantity, location, and configuration of the air handling units shall be verified through LCC analysis. The baseline system required by these standards shall be as follows:
      a. LABS: 100% outside air, single duct, variable air volume, central air-handling units with single duct VAV boxes with hot water reheat coils.
         i. Lab Exhaust—Headered system connecting all chemical fume hoods, ducted bio-safety cabinets, and general lab exhaust to common lab exhaust fan system located on roof. Lab exhaust shall terminate with stack to exhaust contaminants to provide acceptable dilution and prevent recirculation of containments into building ventilation.
         ii. Exhaust Energy Recovery—Laboratory facilities with total exhaust greater than 15,000 CFM shall include heat energy recovery systems to precondition outside air. Energy recovery systems will be designed for zero cross-contamination.
      b. CLASSROOM/OFFICE: Single duct, variable air volume, central air-handling units with parallel fan powered VAV boxes with hot water reheat coils with approval as needed. Building ventilation shall be provided by dedicated outside air pre-treatment unit(s).
         i. Exhaust Energy Recovery – Not recommended, due to reduced hours of operation for Classroom and Office
Facilities, except where required by ASHRAE 90.1 or requested by the University.

c. DORMITORY: Single duct, variable air volume, central air-handling units with parallel fan powered VAV boxes with hot water reheat coils with approval as needed, zoned for individual living suite control. Building ventilation shall be provided by dedicated outside air pre-treatment unit(s).
   i. Exhaust Energy Recovery –ASHRAE 90.1 establishes minimum requirement; however, individual pre-treat units over 8,000 CFM shall be evaluated for the use of exhaust energy recovery.
   ii. Common building areas will be served by single duct, variable air volume; central air-handling units with parallel fan powered VAV boxes using hot water re-heat coils with approval as needed.
   iii. A system consisting of individual four-pipe fan coil units for each dorm room or suite may be selected as the preferred mechanical system. This selection will be made at the discretion of the University, based on specific building program and marketability. Building ventilation shall be provided by dedicated outside air pre-treatment unit(s) ducted directly to the room fan coils

2. Utilize dedicated 100 percent outside air handling units to pre-treat ventilation air prior to delivery to main central air handling unit(s). Provide outside air handling units dedicated to a single or group of central air handlers consistent with prudent engineering practice and to facilitate convenient building operation and shutdown.

3. Exhaust energy recovery units shall not exceed 50,000 CFM.

4. Locate building air intakes as high as possible to ensure the cleanest possible air. Devote special attention to noxious fume exhaust systems to make certain that the exhaust contents escape boundary layer entrainment and subsequent contamination of the building or its neighbors.

5. Use variable frequency drives (VFDs) for fan static pressure control.

6. Control air handling system outside air ventilation rates using a carbon dioxide based demand ventilation control strategy to reduce the total supply or outside air during periods of reduced occupancy. Monitor the carbon dioxide levels at in the zones as well as outdoor levels and vary ventilation rates to track a carbon dioxide offset consistent with ASHRAE 62 recommendations.

7. Provide an engineered smoke control system where required by NFPA 101 and per the requirements of NFPA 96A.

8. Use plenum-like low friction ductwork sizing with long radius fittings (R/D = 1.5) preferred. Target values for air duct design velocities are 1,500 feet per minute on trunks and 800 feet per minute on runouts and drops.

9. Construct supply duct risers to withstand minimum 4” pressure class, construct horizontal ductwork to withstand minimum 2” w.c. of air pressure. Seal ductwork to SMACNA seal Class A.
10. Provide balancing dampers at supply, return, and exhaust branches when connected to larger ducts. No cable damper adjustment cable extensions allow unless approved prior by owner.

11. Provide laboratories or areas with high airflow rates with special design consideration for pollutant containment, humidity control, and for energy recovery or reduction.

12. Provide night setback temperature control on classroom/office buildings. Laboratory temperature setback shall be evaluated based on specific environmental requirements of laboratory space.

B. Waterside

1. Chilled Water
   a. Use full reverse-return routing on all chilled water coil piping.
   b. Control chilled water flow through units with 2-way valves.
   c. Chilled water design supply water temperature should be 42 degrees F, with a minimum return water temperature of 58 degrees F to optimize pipe sizing for water systems. This shall be accomplished without the use of blending stations.
   d. Modulate chilled water pumps with variable frequency drives.
   e. Chilled water pumps shall typically be end suction type with mechanical seals and bronze fitted and connected to campus chilled water loop whenever practical.
   f. Provide building chilled water pumps to handle full building differential pressure. Provide bypass and isolation valves around building chilled water pump.

2. Hydronic heating shall be provided via shell and tube heat exchangers utilizing campus steam where available.

3. Provide sufficient unions and flanges to permit removal of equipment.

4. Provide dielectric unions or dielectric nipples with a non-dielectric union to join dissimilar piping materials.

5. Provide a minimum 2 inch clearance between insulated piping and other piping, structural members or other obstructions.

6. Provide drain valves at low points and automatic air vents at high points. Use eccentric reducers to maintain top of pipe level.

7. For closed-loop hydronic heating systems, provide effective chemical water treatment to minimize effects of oxidation, scale, and other typical contaminants. Ion exchange softeners are not required for average makeup water tap hardness below 100 parts per million (ppm), or 5.8 grains per gallon.

1.04 Mechanical System Warranties:

A. All mechanical systems, components and controls shall be provided with a minimum 12 month warranty initiating upon substantial completion of building. Specific mechanical components may have longer warranty periods. Warranty shall be unconditional and include material, labor and response within 24 hours of notification.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. ASHRAE Handbook – HVAC Applications
B. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture
C. MSS SP-69 – Pipe Hangers and Supports - Selection and Application.
D. SMACNA Handbook – HVAC Duct Construction Standards

1.03 Requirements:

A. Metering:

1. Building utilities are required to be metered including but not limited to: Chilled water, steam, condensate, and electricity. Building BTU metering shall also be provided through the BAS by utilizing chilled water flow and temperature sensors on chilled water supply and return piping. Locate hydronic metering equipment inside a machine room. Provide isolation valves to accommodate meter service. Install per manufacturer’s recommendations regarding straight runs of pipe upstream and downstream of metering equipment.

2. For buildings with mixed occupancy (E&G and non-E&G), provide sub-metering to properly allocate utility costs between organizations. Coordinate sub-metering requirements with the University.

3. Refer to section 5.23.09 for further utility metering requirements.

B. Valves:

1. Provide valves with extended stems to be accessible on outside of insulation. Valve body and stem shall be insulated.

2. Provide means of access where valves are not exposed.

3. Provide valve vaults or boxes, as conditions demand, to provide access to valves installed below grade.
4. Hydronic equipment connections shall be provided with shutoff valves on supply and return piping.

C. Hangers and Supports:

1. Design piping systems to utilize pipe hangers, inserts, and supports in conformance with International Mechanical Code, MSS SP-58 and MSS SP-69.

2. Provide hangers fabricated to allow adequate vertical adjustment of 1.5 inches minimum after installation while still supporting the load. The use of pipe hooks, chains, or perforated iron piping for support is prohibited.

3. Provide pipe hangers within 12 inches of each change in direction and provide hangers on both sides of line valves.

4. Provide vertical piping support at each floor. For pipe risers exceeding three floors, evaluate pipe supports for longitudinal expansion and support requirements. Support riser piping independently of connected horizontal piping.

5. Provide supports for ductwork and accessories in accordance with SMACNA requirements.

6. Provide four inch high concrete housekeeping pads and equipment bases for the following: outdoor equipment on grade, indoor floor mounted equipment in mechanical rooms and penthouse equipment rooms. Housekeeping pads shall extend a minimum 6 inches beyond the equipment or supported member in all directions. Provide pads with half-inch chamfer on all exposed edges, placed and finished smooth and level to ensure proper and continuous support for the bearing surfaces of equipment.

7. Provide prefabricated, factory insulated curbs for roof-mounted equipment, a minimum of 12 inches in height above finished roof surface. Provide curb pitches to match roof slope where required.

8. Provide sleeves for all ductwork and pipe penetrations through walls, roofs, or floors. Provide sleeves larger than pipe or ductwork to accommodate insulation thickness. Provide sleeves in non-load bearing surfaces fabricated of galvanized sheet metal and sleeves in load bearing surfaces constructed of uncoated carbon steel pipe. Sleeves shall not be installed in structural members unless specifically approved by the University. Caulk all sleeves water and airtight. Provide UL listed sealant between pipe and sleeve as required by code. Provide escutcheon around penetrations in finished areas.

9. Provide Linkseal (or approved equal) assembly for pipe penetrations through waterproofed floors and walls.
10. Where piping or ductwork penetrates a floor, ceiling or wall, provide fire stopping insulation, sealed airtight, to close off penetration space between pipe, ductwork, and adjacent work. Provide escutcheon covers at both sides of penetration.

11. Where piping or ductwork penetrates a fire rated floor, wall, or ceiling, provide fire-safe insulation so that the assembly, when complete, is UL listed and equals the fire rating of constructed penetrated.

12. Provide concrete-filled, spring-isolated inertia bases installed on top of concrete housekeeping pad for rotating mechanical equipment, including but not limited to fans and pumps.

13. Fans greater than 5,000 cfm shall be rigidly mounted to floor with no vibration isolators. The fan shall be dynamically balanced and tested at the factory such that displacement does not exceed 1.5 mils peak to peak in any direction. Typical spring isolators may be specified with University approval.

D. Vibration and Sound Control:

1. Design mechanical equipment, piping, and ductwork to be installed with vibration isolation devices, as required, to minimize transmission of noise and vibration transmitted to the building structure or adjacent spaces in accordance with the latest version of ASHRAE Handbook – HVAC Applications.

2. Provide flexible connectors between ductwork and connections to air handling equipment. External isolation supports not required for fan-coil units with internally isolated fans.

3. Provide flexible connectors for piping connections to rotating equipment. For pipe systems 2 inches and smaller, provide braided stainless steel flexible connectors. For pipe systems 2 inches and larger, provide Kevlar reinforced rubber, double-sphere flanged flexible connectors.

4. Design equipment, supports, and connections such that maximum interior room background sound levels do not exceed the levels set forth in ASHRAE Handbook – HVAC Applications. Coordinate wall and slab construction requirements with Design Professionals to ensure conformance.

5. Pump bases shall include support for suction and/or discharge piping elbows.

E. Mechanical Identification:


F. Testing, Adjusting, and Balancing:
1. Testing, adjusting, and balancing (TAB) services for HVAC, piping, ductwork, and plumbing systems shall be provided in accordance with Associated Air Balance Council (AABC) Standards. TAB work shall be done by a University approved, independent contractor.

PART 2: PRODUCTS

2.01 Motors:

   A. Refer to Section 5.26.60 for motor standard.

2.02 Valves:

   A. Section Valves 2” shall be gate or ball type, 2-1/2” and larger shall be gate or butterfly type.

   B. Shutoff Valves 2” shall be gate or ball valves, 2-1/2” and larger shall be gate or butterfly valves.

   C. Drain Valves 2” shall be gate or ball valves, 2-1/2” and larger shall be gate valves.

   D. Check Valves shall be spring-loaded silent type.

   E. Ball valves shall be full-port, 3-piece, with stainless steel trim.

   F. Ball valves should be full-port, with stainless steel trim and hardware.

END OF STANDARD
PART 1: GENERAL

1.01  Purpose:

   A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section so that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02  References:

   B. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation
   C. ASTM C534 – Preformed Elastomeric Cellular Thermal Insulation
   D. ASTM C547 – Mineral Fiber Preformed Insulation
   E. ASTM C552 – Cellular Glass Block and Pipe Thermal Insulation
   F. ASTM C553 – Mineral Fiber Blanket and Felt Insulation
   G. ASTM C612 – Mineral Fiber Block and Board Thermal Insulation
   H. ASTM C1126 – Rigid Cellular Phenolic Thermal Insulation
   J. MSS SP-69 Pipe Hangers and Supports – Selection and Application

1.03  Requirements:

   A. Provide insulation and associated accessories with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.
   B. Provide piping and ductwork insulation thickness and thermal conductivity in conformance with the latest edition of ASHRAE 90.1.
   C. Provide duct and pipe insulation continuous through walls, partitions, ceiling openings and sleeves.
   D. Provide UL-approved assemblies for pipes and ducts passing through fire-rated floors, walls, or partitions as required.
   E. Provide a continuous, unbroken, vapor seal on all cold pipe surfaces. Guides and anchors
secured directly to cold surfaces shall be adequately insulated and vapor sealed to prevent condensation. Pipe Insulation shall run continuously through supports and hangers. Use high compression strength insulation section at support hanger and cover with galvanized steel shield.

F. Provide aluminum jackets, 0.016” thick, for exterior pipe and equipment insulation covers. For interior piping in mechanical rooms or exposed locations, provide aluminum jackets, 0.016” thick for all piping below 6 feet above finished floor. Locate seams on bottom side of horizontal pipe.

G. Jackets for Piping Insulation shall conform to requirements of ASTM C921, Type II for piping with temperatures above ambient.

H. Provide insulation protection shields fabricated from galvanized steel at all pipe hangers in accordance with MSS SP-69.

I. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations.

J. Provide staples, bands, wires, cement, adhesives, sealers, and protective finishes as recommended by insulation manufacturer for applications indicated.

K. Provide flexible reusable insulation blankets for equipment requiring access such as pumps, strainers, etc.

L. Insulate valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut units.

M. For main loop chilled water piping insulation, utilize the Utilities and Energy Management specifications. The scope of this piping insulation is for the main chilled water loop through the discharge valve of the primary chilled water pumps.

PART 2: PRODUCTS

2.01 Piping Insulation Materials:

A. Rigid Phenolic Insulation: Shall be CFC free and meet or exceed requirements of ASTM C1126, Type III, Grade 1 to 250 °F service. Provide with factory-applied jacket suitable for the installation location.

B. Calcium Silicate: Shall meet or exceed the requirements of ASTM C533, Type I. Provide insulation with manufacturer’s recommended jacket.

C. Fiberglass Piping Insulation: Shall meet or exceed requirements of ASTM C552, Class 1, noncombustible, with factory applied white kraft foil vapor barrier unless otherwise indicated.

D. Flexible Elastomeric Closed Cell: Shall meet or exceed requirements of ASTM C534, Type
I, tubular grade. Provide finish coating.

E. **Cellular Glass**: Shall meet or exceed requirements of ASTM C552, Type II. Provide factory cover and vapor retarder finish.

2.02 **Equipment Insulation Materials**:

A. **Mineral Fiber**: Shall meet or exceed requirements of ASTM C 547, C553, Types I, II or III or C612, whichever applies. Provide with factory-applied jacket.

B. **Calcium Silicate**: Shall meet or exceed the requirements of ASTM C533, Type I or II. Provide insulation with manufacturer’s recommended jacket.

C. **Flexible Elastomeric Cellular**: Shall meet or exceed the requirements of ASTM C534, Grade 1, Type I or II. Provide Type II with vapor retarder skin on one or both sides of insulation.

D. **Piping Insulation Sealing**: On any cold pipe insulation, seal all joints, covering and staples completely with mastic after each section is coated and sealed to pipe with Childen CP 34√ mastic or approved equivalent.

2.03 **Ductwork Insulation Materials**:

A. **Fiberglass Ductwork Insulation**:

1. **Fiberglass Blanket** insulation with a density of 1 pound per cubic foot and thermal conductivity (k value) of 0.29 @ 75 °F mean temperature. The blanket shall have a vapor barrier facing of an aluminum foil and kraft paper lamination sandwiching a fiberglass scrim for reinforcing.

2. **Rigid Fiberglass Board**: Three pound per cubic foot minimum density glass fiber rigid board insulation with factory applied white foil reinforced All Service Jacket (ASJ).

3. **Semi-Rigid Fiberglass Board**: Three pound per cubic foot minimum density glass fiber semi-rigid board insulation with fiber perpendicular to the surface and with factory applied white foil reinforced vapor barrier jacket (ASJ). Insulation shall be equal to E.O. Woods Company “Rigid-Wrap”.

B. **Flexible Unicellular**: Flexible Unicellular insulation blanket, protected by Armaflex finish protective coating (minimum 2 coats).

C. **Ductwork Insulation Accessories**: Provide Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

D. **Ductwork Insulation Compounds**: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

E. **Ductwork Insulation Sealing**: Insulation shall be wrapped tightly on the ductwork with all circumferential joints butted and longitudinal points overlapped a minimum of 2”. Adhere insulation to metal with 4” strips of insulation bonding adhesive at 8” on center. On circumferential and longitudinal joints, the 2” flange of the facing shall be secured 9/16”
flare door staples applied 6” on center and taped with 4” wide fiberglass tape embedded in Childers CP-34 white vapor barrier emulation and covered with Childers CP-34 or approved equivalent until the tape is completely covered. All pin penetrations or punctures in facing shall also be taped. Vapor sealing of joints is not required on hot duct application where concealed.

PART 3: EXECUTION

3.01 Piping System Insulation:

A. **Plumbing System Omissions**: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.

B. **HVAC Piping System Omissions**: Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.

D. Steel piping insulated with rigid phenolic shall be coated with epoxy finish prior to insulation installation.

E. Insulate piping systems per table 23.07.1

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>MATERIAL</th>
<th>VAPOR BARRIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChW supply/return</td>
<td>Cellular Glass</td>
<td>Yes</td>
</tr>
<tr>
<td>Fin Water</td>
<td>Flexible Elastomeric Closed Cell</td>
<td>Yes</td>
</tr>
<tr>
<td>Existing wet ChW piping, tunnel ChW piping, primary ChW piping in machine rooms.</td>
<td>Cellular Glass</td>
<td>Yes</td>
</tr>
<tr>
<td>Heating Hot Water supply/return (max. 250 °F), Steam Condensate</td>
<td>Mineral Fiber, Calcium Silicate</td>
<td>No</td>
</tr>
<tr>
<td>Low Pressure Steam (max. 250 °F)</td>
<td>Calcium Silicate</td>
<td>No</td>
</tr>
</tbody>
</table>
3.02 Equipment Insulation:

A. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around nameplates.

B. Insulate the following equipment per Table 23.07.2: Cold refrigeration equipment not factory insulated, drip pans under chilled equipment, cold and hot water storage tanks, water softeners, duct mounted coils, cold and chilled water pumps, air handling equipment not factory insulated, expansion and air separator tanks, heat exchangers, hot water generators, and pumps handling media above 130 °F, except pumps on steam condensate return units. This requirement would include condensate receivers. If there is not a flash tank upstream of the receiver, then a leaking low-pressure trap would heat the condensate receiver well above the 212 °F. This temperature causes the condensate pumps to fail. Leave the condensate receivers uninsulated to help protect the pumps.

Table 23.07.2

<table>
<thead>
<tr>
<th>EQUIPMENT HANDLING MEDIA AT INDICATED TEMPERATURE</th>
<th>INSULATION MATERIAL</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 34 degrees F</td>
<td>Flexible Elastomeric Closed Cell or Cellular Glass</td>
<td>1.5 inches</td>
</tr>
<tr>
<td>35 to 60 degrees F</td>
<td>Closed Cell or Cellular Glass</td>
<td>1.0 inches</td>
</tr>
<tr>
<td>61 to 200 degrees F</td>
<td>Mineral Fiber Calcium Silicate</td>
<td>2.0 inches</td>
</tr>
<tr>
<td></td>
<td>Calcium Silicate</td>
<td>2.0 inches</td>
</tr>
<tr>
<td>201 to 400 degrees F</td>
<td>Calcium Silicate</td>
<td>4.0 inches</td>
</tr>
<tr>
<td>401 to 600 degrees F</td>
<td>Calcium Silicate</td>
<td>6.0 inches</td>
</tr>
<tr>
<td>&gt;600 degrees F</td>
<td>Thickness necessary to limit external insulation temperature to 120 degrees F</td>
<td></td>
</tr>
</tbody>
</table>

3.03 Duct System Insulation:

A. Double-wall ductwork shall be provided where internal insulation or sound absorbing linings have been provided.

B. Hot and cold interior ductwork shall be insulated with Flexible Fiberglass insulation. Provide thickness to achieve minimum R-value requirements per ASHRAE 90.1.
C. Exterior ductwork shall be insulated with Flexible Closed-Cell Elastomeric insulation. Provide with aluminum jacketing sealed water tight. Slope insulation on top of ductwork to promote drainage.
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. ASME B 40.1 - Gages - Pressure Indicating Dial Type - Elastic Element.

B. ASME B40.3 - Bimetallic Actuated Thermometers.


E. FCI 70-2 - Fluid Controls Institute, Control Valve Seat Leakage (Supersedes ANSI B16.104).

F. ISA 75.01 - Flow Equations for Sizing Control Valves.

G. ISA 75.02 – Control Valve Capacity Test Procedures.

H. ISA TR75.04.01 – Control Valve Stability.

I. ISA 75.05 - Control Valve Terminology.

J. ISA 75.13 – Method of Evaluating the Performance of Positioners with Analog Input Signals and Pneumatic Output.

K. ISA 75.19.01 - Hydrostatic Testing of Control Valves.

L. ISA 75.25.01 – Test Procedure for Control Valve Response Measurement from Step Inputs.

M. ISA TR75.25.02 – Control Valve Response Measurement from Step Inputs.

N. NEMA 250 – Enclosures for Electrical Equipment (1000Volts Maximum).

O. NFPA 70 - National Electrical Code

Q. Underwriter’s Laboratories – (specify individual standards per project application).

1.03 Requirements:

A. Provide identical field devices for existing facility modifications where possible.

B. Provide verification that instruments and control valves supplied are properly sized per industry and manufacturer’s standards to meet specified performance criteria for the intended application.

C. Provide instruments including pipe, tubing, manual valves, supports, pipe and tube fittings, wire/cable, conduit, tray, terminations, racks, mounting stands, mounting plates, and other accessories as needed to complete a working and operable instrumentation and control system.

D. Provide intrinsic safety barriers for instruments and valve controllers that are installed in hazardous areas as defined by NFPA 70.

E. Protect equipment from entry of foreign materials by using temporary covers, caps, closures and store equipment in environmentally controlled space until installation of equipment are complete.

F. Verify manufacturer and model number of equipment listed herein as to availability. Substitutions require UT approval.

G. Input Sensor accuracy:

1. Temperature:
   a. Space – +/- 0.8 F, over 0 to 130F range
   b. Duct Air – +/- 0.8F, over 0 to 130F range
   c. Outside Air - +/- 1F, over -30 to 130 range
   d. Water – +/- 0.5F, over 0 to 230F range
   e. Delta-T – 0.1F

2. Relative Humidity – +/- 2%, over 20 to 95RH range

3. Carbon Dioxide – 5%

4. Flow:
   a. Fluid – +/- 1% of range
   b. Air – +/- 2% of range

5. Pressure:
   a. Static Duct – +/- 0.1” WG, over 0-5 inch range
   b. Filter status dp – +/- 0.1” WG, over 0-2 inch range
   c. Switches: +/- 1% of range

6. Level:
a. Cooling Tower Basin – 1 inch
b. Tanks – 0.5 inch

7. Electrical:
   a. KWH - +/- 1% of range
   b. KW - +/- 1% of range

**PART 2: PRODUCTS**

2.01 Control Valves:

A. Approved control valves are: VSI V-Ball valves or UT approved equal.

B. Preference for mounting of temperature control valves is for serviceability from floor without the use of ladder—maximum height 5’0” AFF. Where control valves are above serviceability height, locate over equipment in an accessible location such that top of equipment can be used for service platform. Other types of service valves shall be similarly located. Where service valves are mounted 8 feet above the floor (or other walkway) and not over service platform provide with Rotohammer chain wheels and safety-trimmed chains.

C. Valves shall have a manual means of operation independent of the actuator.

D. Provide valves with the manufacturer’s name, pressure rating and flow direction clearly marked on the outside of the valve body.

E. Control valves of the same type shall be of the same manufacturer when possible.

F. Size valves in accordance with ISA 75.01 flow equations with valve sized to pass 110 percent of maximum flow.

G. Control valve noise limit shall be 65 dB at 3-feet.

H. Valve failure mode shall be designed to ensure safe operation and shut down of the appropriate process equipment.

I. Control valve terminology shall comply with ISA 75.05.

J. Valve leakage shall comply with FCI 70-2, Class IV.

K. Provide valves with equal percentage or modified equal percentage flow characteristics for modulating applications.

L. Valves shall be hydrostatically tested at the factory simulating dead end service at the design pressure in psig.

M. Hydronic system control valves shall be:
   1. Valves 3” and smaller shall be characterized v-ball with a notch, full-port, 3-piece, with stainless steel trim.
   2. Valves larger than 3” shall be high performance butterfly type with resilient seated with bronze or stainless steel discs, bubble-tight, lug-type and gear operated.
N. Steam system control valves shall be globe style where renovations for pneumatic actuation characterize v-ball.

2.02 Valve and Damper Actuators:
   A. Valve and damper control actuators shall be electronic except renovation applications where existing control system is to remain pneumatic.
   
   B. Valve and damper actuators shall be provided with stall protection to prevent actuator damage throughout the actuator’s rotation.
   
   C. Valve actuators shall be provided with position feedback as follows:
      1. Open/Close: limit switches (full open and full close), contact closures.
      2. Modulating: 0-100% feedback, 0-10 V DC, 4-20mA signal.
   
   D. Actuators used for power-failure or safety applications shall be equipped with an internal spring return mechanism or an uninterruptible power supply (UPS).
   
   E. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and have a 2-10 Vdc or 4-20 mA operating range.
   
   F. Valve actuators shall provide the following minimum close off pressure ratings 150% of total system (pump) head. Belimo VS series or approved equal.
   
   G. Actuators shall feature the ability for Operators to manually position each actuator when actuator is not powered. Non-spring return actuators shall feature an external manual gear release. Spring return actuators with more than 60 in.-lb torque capacity shall feature a manual crank.
   
   H. Provide a minimum of one actuator for each damper and one actuator for each 16 square feet of damper area. Belimo F series, Siemens Open Air G, or approved equal.
   
   I. Dampers 16 square feet and smaller shall be driven by an externally mounted damper actuator. Dampers larger than 16 square feet shall have each section independently driven by a separate externally mounted damper actuator. Actuators on multi-section dampers shall operate smoothly and in unison.

2.03 Building Metering:
   A. Chilled or Hot water BTU meters:
      1. Rosemount Magnetic flow-meter (model 8705 w/8721D remote transmitter)
      2. Flow tube should be sized to operate within a velocity range of 2-15 ft./sec.
      3. Differential temperature to use Rosemount transmitter (model 3144) with matched pair of RTD temperature sensors on supply and return lines.
      4. BTU calculations to be calculated with Kessler-Ellis Products (KEP) Supertrol II energy meter.
B. Domestic water meters:

1. Sensus turbine meter (model W-1000 DR w/impulse contactor)

2. SRH Compound turbine water meters are to be used for 4-6” applications.

3. Local display:
   a. Volumetric rate
   b. Totalizer

4. Output shall be scaled pulse transmitter for flow rate to BAS

5. Water meter strainers of AWWA type shall be used.

C. Electrical power meters:

1. ION 8600 Smart Power Meter

2. Local Display:
   a. Amperage
   b. Voltage (per phase and phase-to-phase)
   c. KW
   d. Power Factor

3. Output shall be Modbus TC/IP data link to BAS

D. Condensate Meters:

1. Cadillac volumetric type if locate-able ahead of the condensate receiver, else
   Badger 2” Turbo meter turbine with cast iron body and MSER 01 register reading in
   pounds of water.

2. Local display:
   a. Volumetric rate
   b. Totalizer

3. Output shall be scaled pulse transmitter for flow rate to BAS

E. Steam Meter

1. McCrometer V-Cone sensor unit with a Rosemount 3051DP pressure transmitter.

2.04 Field Input Devices:
A. Provide same manufacturer's equipment for similar type installations, i.e., pressure transmitters shall be supplied from one manufacturer.

B. Provide local process gauges with dial sizes between 3 to 5-inches in diameter unless location is further away than 3-feet when 6 to 8-inch or larger gauges will be required. Gauges shall use 1/2 NPT connections.

C. Provide analog process gauge scales so that the expected normal operating value is approximately 1/2 of full-scale range. Working pressure in all cases shall be limited to 75 percent of full-scale range.

D. Provide transmitters so that the maximum expected process value is approximately 90 percent of the calibrated range.

E. Provide remote sensing electronics for transmitters with local indication if needed to mount at a location accessible by plant operators as close as possible to sensing point. Output signal to be 4-20mA unless otherwise specified.

F. Provide transmitters with required environmental ratings for service duty, for process and location (indoor or outdoor) temperature and pressure ratings.

G. Provide transmitters with integral display units.

H. Provide process instruments with wetted parts that are compatible with the intended service.

I. Field sensors measurement methodology (type of sensor) dependent upon system service conditions and application. Typical applications are included below.

J. Provide 1/2” brass body, stainless steel ball isolation valves at locations where sensor lines tap into fluid

K. Switch contacts shall be rated for 120 VAC at 5 amperes.

L. Provide field calibration of sensors:
   
   1. Calibrate analog instruments to verify accuracy and linearity in accordance with standard industry practices or manufacturer's recommendations.

   2. Calibrate digital sensors to verify accuracy, dead bands, and repeatability in accordance with standard industry practices or manufacturer’s recommendations.

   3. Test equipment shall have accuracy two times or better than equipment being tested, traceable to NIST.

   4. Calibration and installation records shall be prepared and maintained with the following information:
a. Tag number.

b. Date component received.

c. Purchase order number.

d. Serial number.

e. Calibration data, minimum of 3 points.

f. Date of calibration.

g. Person performing calibration.

h. Date component installed.

i. Test Equipment: Manufacturer, model number, date calibrated calibration lab, and accuracy.

j. Attach calibration sticker to the instrument. Submit sample calibration stickers to Owner for approval. Coordinate sticker location on each type of instrument with Owner. Sticker content:

   i. Date calibrated.

   ii. Calibration due date.

   iii. Initials of person performing calibration.

k. Provide field calibration kits for carbon monoxide and dioxide sensors.

M. Temperature:

1. Provide 3-wire thermistor Type II or Type III (bead coated with glass, covered in metal sheath, encapsulated with moisture proof epoxy) probe temperature sensors as required to meet accuracy and service conditions. RTD type sensors to be used in special conditions with owner’s approval.

2. Provide matched pair of sensors where differential temperature measurements are made.

3. Provide sensor type and mounting material compatible with environment and service conditions.

4. Room Sensor: Thermistor encased in a wall mounted enclosure for mounting on a standard electrical box. Sensor shall have setpoint adjustment and override push button. Sensor housing and wall cover plate shall be one piece with override
button and setpoint adjustment integral with housing. Kele ES3-AO or approved equal.

5. Duct Sensor: Encapsulated moisture proof coated thermister Type II or Type III Material. All sensors in ducts shall be of the single point type. Precon model ST-R3R, ST-D3, or approved equal.

6. Averaging Sensor: Employed in ducts which are larger than 24-inches. The averaging sensor tube must contain at least one sensor for every 3 feet of length, with a minimum tube length of 12 feet. Precon model ST-FZ or approved equal.

7. Outside Air Sensor: Approved thermistor, sheathed in stainless steel tubing and mounted inside a ventilated, treated, shield to minimize radiant energy and wind effects. Precon model ST-03 or approved equal.

8. Thermostats: Programmable, low voltage. The thermostat shall feature a push button for selecting after hours operation. Setpoints and other operator selectable parameters shall be adjustable from the thermostat. Overrides are not required in public corridor, shower and restrooms.

9. Immersion Sensors: Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe. Precon model ST-W3-S-XH or approved equal.

10. Temperature Gauges: Bimetallic helix actuated type, and shall have a white dial with black figures, and pointer zero adjustment. Accuracy shall be plus or minus 1 percent of the range. Gauges shall conform to ANSI/ASME B40.1.

11. Thermowells: Provide 304 Stainless Steel well, sized for 1/2 the pipe diameter or 6 inches whichever is less. Well shall be installed with Thread-o-let. Kele WEL-S with threadolet or approved equal.

N. Analytical Instruments:

1. Humidity Sensors:
   a) Duct mounted sensor shall have a minimum 6-inch rigid probe. Duct sensors shall be provided with a sampling chamber and calibration adjustments. RE Technology model HD20K or approved equal.
   
   b) Wall mounted devices shall have appearance similar to temperature sensor devices. Cover shall be tamper-resistant.
   
   c) When temperature element is required for same location, provide a combination sensor (temperature and humidity).
   
   d) Room sensor:
   
      i. Precision control: RE Technology model HW1K or approved equal.
ii. General: RE Technology model HW20K or approved equal.

e) Outside sensor: RE Technology HO20K or approved equal.

2. Conductivity:
   a. Platinum electrode.
   b. Automatic temperature compensation.

3. pH/ORP:
   a. Glass electrode
   b. Automatic temperature compensation.

O. Freezestats:

1. Provide for freeze protection of all air-handling unit coils using outside air. The freezestat set point shall be determined as a function of outdoor air temperature, amount of outdoor air being introduced to the air-handling unit, return air temperature, and amount of return air to the unit.

P. Carbon Monoxide Sensor:

1. Sensor shall have a local display, analog output, and relay output contacts.

2. Provide aspirated enclosure for duct mounting. Readings from 0 to 200 ppm, Kele model WCO-1B or approved equal.

Q. Carbon Dioxide Sensor:

1. Based on Non-dispersive infrared (NDIR) operating principle. Sensor shall have a local display, analog output, and relay output contacts.

2. Provide duct mounted units only, readings 0 to 2000 ppm, Valtronics model 6289D-D or approved equal.

R. Occupancy Room Sensor:

1. Based on passive infrared operating principle through a segmented Fresnel lens. Sensor shall have a programmable delayed off, adjustable coverage range, and manual override mode.

S. Pressure (Absolute, Gage, Differential):
1. Air pressure measurements in the range of 0 to 10-inch water column will be accurate to plus or minus 1 percent using a solid-state sensing element.

2. Differential pressure measurements of liquids or gases shall be accurate to plus or minus 0.5 percent of range. The housing shall be NEMA 4 rated for outdoor elements.

3. Provide liquid fill for gages on lines with vibrations and snubbers for pulsation protection. Provide needle valve to isolate each gauge.

4. Transmitters:
   a. Electronic capacitance or piezio-resistive type
   b. Accuracy shall be plus or minus 0.5 percent of the range with overload protection.
   c. Provide three valve manifold assembly for zero and span calibration and maintenance of sensor.

5. Pressure Gauges:
   a. Bourdon tube type, and shall have a diaphragm actuated pointer, white dial with black figures, and pointer zero adjustment.
   b. Accuracy shall be plus or minus 0.5 percent of the range with overload protection.
   c. Gauges shall conform to ANSI/ASME B40.1.

6. Air Pressure Transducers:
   a. Switch of proof: Select range for minimum flow operations. Dwyer model 1910 with SPDT contacts or approved equal.
   b. Low Differential Pressure: Select range per process condition where control setpoint is in the top 50% of the sensor range. Provide integral LCD display, Setra model 267 or approved equal.

7. Water Differential Pressure Sensors:
   a. DP Switch: Brass bellow, enclosed SPDT snap acting switch, contact rating per application. Penn P74 or approved equal.
b. Transmitters: Provide with stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and three valve manifold. Setra model M230 or approved equal.

T. Flow:

1. Provide flow elements in horizontal pipe runs in accordance with good metering practices and in accordance to manufacturer’s requirements for upstream and downstream pipe diameters. Coordinate installation requirements with manufacturer.

2. Transmitter:
   a. Air: Averaging Pitot type with multiple sensors for static pressure measurements distributed across the air stream. Kele KMS series or approved equal.
   b. Fluid: Electromagnetic (energy metering), Turbine insertion type, with dual sensor for basic fluid measurements. Onicon F-1210 or approved equal.

3. Switch:
   a. Air: Differential Pressure diaphragm type single snap action switch. Dwyer model 1626 or approved equal.
   b. Fluid: Thermal Dispersion type with adjustable setpoint from 15% to 90 of flow range setting. Dwyer TFS or approved equal.

U. Water/Moisture/Flood Detector:

1. UT Standard analog moisture sensor. Furnished by Owner installed by contractor.

V. Level:

1. Open Pit Sumps:
   a. UT Standard analog level sensor. Furnished by Owner and installed by contractor.

2. Enclosed Sumps:
   a. Float type switch suitable for fluid in which immersed. Switch shall be assembly mounted, designed, and located for ease of maintenance access, removal and level adjustment. GEMS LS1750 stainless steel single station level switch or approved equal.

3. Receiver Tanks:
   a. UT Standard analog level sensor. Furnished by Owner and installed by contractor.

W. Current:
1. Transmitters: Battery powered combination split core, transformer type with built-in rectifier, zero/span adjustment, and two-wire output.

2. Switches: Battery powered, solid state with adjustable trip. Provided for equipment status feedback.

X. Voltage:

1. Transmitters: UL listed AC voltage self-powered single loop, two-wire type, with zero/span adjust and 4-20mA output.

2. Transformers: UL listed rated for 600vac, with enclosed windings, and built-in fuse protection

PART 3: EXECUTION

3.01 Installation:

A. Install instruments in accordance with manufacturer’s requirements and applicable industry standards.

B. Provide details for typical and special equipment installations on construction documents.

C. Provide power surge and transient suppression for power circuits from an electrical panel, located on the incoming power circuit serving the equipment. Kele model DTK-120HW or approved equal.

D. Install field instruments in such a manner and at such a height as to allow convenient access for readings, calibration and maintenance.

E. Install instruments in steam, liquid and liquid sealed service below their process connection point. Slope connections down to the instrument with a slope of 1 inch per foot.

F. Install instruments in gas and non-condensable vapor service above their process connection point. Slope connections up to the instrument with a slope of one inch per foot.

G. Support instruments and tubing to relieve strain on connections and to prevent excess vibration or movement.

H. Install piping and tubing in a neat appearance, protected from being stepped on, and include provisions for expansion, drainage and without interference to access to valves or other equipment. Tubing bends are to be made with a tool; hand bends are not acceptable.

I. Provide identification tags for field devices using engraved plastic laminated labels (use stainless steel tags for high temperature service conditions). Secure labels to devices using double sided tape for panels or stainless steel ties for field instruments. Nomenclature shall utilize the UT standard abbreviations and codes and include the following information:

1. Building
3.02 Training:

A. Provide training by factory authorized personnel at the Owner’s facility for instrumentation and control equipment, including the following topics:
   1. Theory of operation.
   2. Hardware configuration and software programming.
   3. Calibration methods.
   4. Preventative and scheduled maintenance.
   5. Diagnosis of hardware and software failures.
   6. Removal and replacement of serviceable components.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. Codes and Standards that are Standard at the University:
   1. AGA Compliance: LC 1-91 – Interior Fuel Gas Piping Systems
   3. NFPA Compliance: Fabricate and install natural gas systems in accordance with NFPA 54 "Natural Fuel Gas Code" and NFPA 30 “Flammable and Combustible Liquids”.
   4. Utility Compliance: Design and install natural gas systems in accordance with local gas utility company.
   5. Code Compliance: Design and install natural gas systems in accordance with International Fuel Gas Code requirements as well as all local amendments.

1.03 Requirements:

A. Design system to achieve a minimum pressure drop of .05 inches w.c., with a minimum pressure downstream of the meter at 7 inches w.c. to 14 inches w.c. and a maximum operating pressure of 5 psig pressure downstream of the meter. Higher operating pressure requires pre approval from U.T. Facilities Services.

B. Design shall include all information required by the Authority Having Jurisdiction and UT Facilities Services and Utilities departments.

C. Design shall include piping layout indicating total equivalent length pipe and all connected equipment, total friction loss in piping system and equipment demand capacities (total connected load) throughout piping system.

D. Indicate minimum pressure requirements at outlet of meter, extent of work to be completed by utility company, meter location, work required by owner to allow meter assembly to be installed, all site information including building location, gas service

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location (utility supply mains), any low pressure cutoff requirements, equipment with pilot lights and all future equipment and capacities.

E. Provide sleeved pipe runs through enclosed spaces, plenums and above corridor ceilings. Ventilate sleeve on both ends to exterior of building. Route piping exposed in ventilated spaces where possible.

F. Base pressure ratings on natural gas piping system maximum design pressures.

G. Provide pipe identification complying with ANSI A13.1 Scheme for Identification of Piping Systems in accordance with the following:
   1. Building Distribution Piping: Plastic pipe markers
   2. Gas Service: Underground type plastic line markers

H. Gas piping entering a building shall first rise above grade exterior to the building and be provided with a wrench operated shutoff valve in the horizontal portion of the exterior piping.

I. It shall be the Contractor’s responsibility to make all arrangements and pay for all services, fees, and material which are required to have the gas company extend its gas main to the property line and to install the regulator and/or meter required for the project.

J. Verify and coordinate, with the actual various users on the site, all the times and timing involved with modification, additions to, or alterations thereof, of gas piping serving these users

K. The gas regulator bypass globe valve shall be sized to provide a pressure drop equal to the regulator when fully open. It shall include provision for locking shut with a large padlock.

L. Provide a wrench operated Balon ball valve at the inlet and discharge side of the gas meter and pressure regulators and at building entrance.

M. Provide zone valves on each floor accessible to occupants for shutting off areas of the building under emergency conditions. Gas piping shall be welded up to these zone valves.

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

O. Route piping in orderly manner to conserve building space and not to interfere with use of space. Maintain gradient and group piping wherever practical at common elevations.

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

Q. Route piping parallel to other piping. Maintain a minimum of 12" clearance between gas piping and steam or hydronic piping above 200 degrees F.
R. Provide shutoff gas cock and drip leg at each gas-fired equipment connection. Comply with equipment manufacturer's instructions.

S. Provide gas shutoff outside building, upstream of meter, at pipe entry to building in adjustable gas service valve box with cover set flush to finish grade.

T. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

U. Establish elevations of buried piping outside the building to ensure minimum cover requirements are met.

V. Provide protective bollards for gas meter installations, horizontally spaced no more than four feet apart and 36” high. Bollards should be constructed of galvanized steel, 6” diameter, with a minimum 0.25” wall thickness, or 4” diameter concrete-filled, schedule 40 galvanized steel pipe. Bollards should be permanent-type, epoxy primed and painted, and anchored to 18” X 42” concrete foundation with ASTM 3/4” x 12” ASTM - A36 galvanized L hook anchor bolts.

PART 2 PRODUCTS

2.01 Pipe and pipe fittings:

A. All pipe used for the fabrication of gas piping systems shall be Schedule 40 black steel pipe ASTM A-53.

B. Unless otherwise specifically required, all steel pipe provided for gas piping systems shall be provided with plain ends and assembled with weld fittings on all pipe 1-1/4” and larger and 3/4” and larger if before the emergency shut off valve. No pipe smaller than 3/4”, except as detailed for laboratory furniture, shall be used. From the emergency shutoff valve to the outlets, the pipe shall be assembled with threaded fittings provided all joints are exposed or within the confines of the laboratory furniture.

C. Machine wrap pipe using 50% overlap wrap, with polyvinyl chloride tape. Hand wrap fittings using 100% overlap wrap extending 6” beyond fitting onto wrapped pipe. Comply with tape manufacturer's installation instructions. Installation standards and procedures of the utility company shall be strictly followed. At a point 6' from the building and the final riser to meter or building entrance point shall be wrapped steel.

D. Unless otherwise specifically shown or called for, gas piping systems installed throughout the building shall be fabricated by a fusion welding process making use of welding fittings. These fittings shall be fittings as specified in other Sections. In no case shall the wall thickness of a fitting incorporated in a gas piping system be less than that of the pipe to which it is jointed.

2.02 Valves:

A. Gas Cocks 2” and smaller shall be AGA approved 150 PSI Balon ball valves with flat or square head with threaded ends.
B. Gas cocks 2-1/2” and larger shall be AGA approved 125 PSI Balon ball valves with square head with flanged ends.

C. Master control valve shall be packless, single seat, bronze body, explosion-proof solenoid operated. It shall be normally closed, UL approved, 120 volt, with automatic reset.

D. Control station shall be pushbutton station mounted in 2-gang box, one normally open key operated contact, and one normally closed pushbutton operated contact. Faceplate shall be inscribed with “Gas Valve Control” on top, “Open” over keyhole, and “Closed” over pushbutton.

E. Pressure regulating valves shall be single stage, steel jacketed, corrosion-resistant gas pressure regulator. Provide with elevation compensator and atmospheric vent routed to outdoors, full size of outlet, and terminated in weather proof hood. Provide with threaded ends for 2” and smaller, flanged ends for 2-1/2” and larger. Size for required inlet and outlet gas pressures, specific gravity and volume flow. Provide gas shutoff valve upstream of each pressure regulating valve.

F. Provide AGA plug valves for shut-off and to isolate equipment, part of systems, and vertical risers.

2.03 Flanges:

A. In all instances in which flanges are required for the installation of flanged fittings for gas lines, the Contractor shall provide Crane or Walworth weld neck pattern, Class 150 forged steel flanges

2.04 Drip Pipes:

A. Drip pipes shall be provided throughout the gas piping systems for the purpose of accumulating moisture and condensate. They shall be sized no smaller than the gas piping to which they are connected in each instance. These drip pipes shall be U-shaped providing an effective water seal of no less than twelve inches (12") of water. The extremity of each U-shaped drip pipe shall be threaded and capped with a suitably sized, screwed pattern, black, standard weight, malleable iron cap.

B. All drip pipes shall be located in an accessible position so that the condensate may either be pumped from the system or so that a water seal shall be provided in the event that the water forming the seal evaporates.

2.05 HEADERS:

A. The gas distribution header installed by this Contractor in the building shall be fabricated of Schedule 40 steel pipe. The pipe and welding materials for this header shall be carefully selected, and the welding operations shall be carefully supervised.

B. Welding nipples neatly aligned shall be provided for the outlets of the header. After the header has been completely fabricated, it shall be temporarily sealed and subjected to a
pneumatic test pressure of 100 pounds per square inch. While the header is subjected to this pressure, all welded joints shall be given an application of soapy water for the purpose of detecting minute leaks which might not otherwise be observed. These leaks shall not be repaired by any peening operations. Such leaks shall be remedied by chipping and re-welding until the header is devoid of leaks at that pressure. The header shall then be subjected to a hydrostatic test pressure of 200 pounds per square inch. Under these circumstances, the test pressure of the water confined in the header shall not decrease in a four hour period of observation. If leaks are encountered, they shall be repaired and re-tested until proven tight.

C. The header shall be provided with a one-half inch (1/2") drain connection "taken off" the bottom of the header and terminated in a suitable Balon ball valve. This one-half inch (1/2") drain connection shall have its origin in a 2" x 1/2" welding reducer having its two inch (2") end so welded to the header as to completely drain that member. Each outgoing branch from the header shall be provided with a Balon ball valve. The nature of the outgoing welding nipples shall be such that these ball valves shall be aligned in a neat horizontal line.

2.06 COCKS:
A. Near the point at which each outgoing line leaves the gas header, the Contractor shall install an AGA approved Balon gas stop valve. These wrench operated valves shall each be provided with an appropriate wrench. Cocks of the same type shall, moreover, be installed at each other point indicated on the Drawings.

2.07 PROTECTIVE COATING:
A. Gas piping systems installed underground shall utilize pipe which has been factory coated with Scotchkote protective resin No. 212. All materials, surface preparation, application and testing shall conform to Federal Specification L-C-530 B-Type 2, dated June 4, 1970. This coating shall be applied by A&A Coating Company, Lone Star, Texas.

B. Underground welded joints and fittings shall be coated with Scotchkote No. 306 epoxy resin and taped with vinyl Scotchwrap-50 brand tape. Flanged joints shall be given two coats of Koppers Company No. 300M Catalyzed Coal Tar Epoxy. Flanged joints will not be allowed under ground.

C. Under no circumstances shall any backfilling operations be begun until these pipe protection operations have been completed.

PART 3 EXECUTION

3.01 TESTING:
A. Natural gas piping shall be tested in accordance with International Fuel Gas Code requirements. Refer to Appendix 6.01.06 for further information.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 "Building Services Piping”.

B. HI Compliance: Design, manufacture, and install pumps in accordance with HI "Hydraulic Institute Standards.”

C. UL Compliance: Design, manufacture, and install pumps in accordance with UL 778 "Motor Operated Water Pumps.”

D. NEMA Compliance: Provide electric motors and components which comply with NEMA standards.

1.03 Requirements:

A. Avoid 3-1/2 and 5-inch pipe in chilled-water systems; except that 5” chilled water meters are acceptable.

B. Drains and vents on chilled-water distribution piping shall consist of Schedule 80 thread-o-lets with stainless steel pipe nipples and bronze gate valves or approved ball valve.

C. All taps shall be constructed of 3/4" Schedule 80 Thread-o-Let, 3/4" 304/316 stainless steel nipples, and 3/4” bronze gate valve or approved ball valve.

D. Provide means for access where valves and fittings are not exposed.

E. Chilled water systems serving secondary loads shall be independently circuited from the primary chilled water system within the building and serve mechanical systems such as standalone computer HVAC, refrigeration equipment, etc. Each loop shall be provided with independent circulating pump. Pump shall be located in easily accessible areas for service and not above ceiling. Secondary loads shall be consolidated into a minimum number of separate chilled water circulating loops. Aggregation of equipment on such loops shall be approved in advance by the University.

F. Chilled water design supply water temperature shall be 42 degrees F, with a minimum return water temperature of 58 degrees F to maximize the usable lifetime (optimize pipe size of existing piping) of water systems. This shall be accomplished without the use of blending stations.
G. Provide sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more hydronic terminals or equipment connections.

H. Provide drain valves on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and at any low point required to completely drain hydronic-piping system.

I. Route groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

J. Select pumps on the ascending side of the efficiency curve. All pumps shall be non-overloading.

K. In all cases, the PSP shall evaluate system conditions and select the optimum pump type and configuration based on efficiency and pump characteristics.
   1. Recommend in-line circulating pumps or close-coupled end suction pumps for low flow (up to 50 GPM) circulating systems.
   2. Recommend base-mounted end suction pumps for circulating systems with flow rates between 50 and 500 GPM.
   3. Recommend horizontal split case, double-suction pumps for applications with flow rates exceeding 500 GPM.
   4. Vertical in-line pumps shall be considered for various applications including limited floor space and shall require University approval.

L. Provide pumps design to operate to 1,750 RPM unless directed otherwise.

M. Provide pumps free of flashing and cavitation at all flow rates between 25% and 125% of design flow under the suction conditions of the pump installation.

N. Provide pumps sized for critical speed of at least 115% of operating speed.

O. Provide base-mounted pumps on minimum of 4" high concrete base equal or greater than 3 times total weight of pump and motor, with anchor bolts poured in place.

P. Provide manufacturer’s recommended clearances as a minimum. Indicate on Drawings required access space around pumps for service.

Q. Design pipe changes off pumps using long radius reducing elbows or eccentric reducers to reduce and minimize turbulence. Provide piping support such that piping weight is not transferred to pump flanges or casing. Provide supports under elbows attached to inertia bases on pump suction and discharge.

R. Provide a minimum of five straight pipe diameters at pump inlet connections. Suction diffusers only allowed if space constraints require their use. Provide line size isolation valve and strainer on pump suction piping. Provide line sized, spring-loaded silent check valve and isolation valve on pump discharge piping.

S. Provide rigid mounting of base-mounted pumps and vertical in-line pumps above 1 HP with flexible pipe connectors between pump and piping system.
PART 2: PRODUCTS

2.01 Piping:

A. Pipe Size 1/2" (connections to fan coil units): Type "L" copper w/ wrought copper fittings.

B. Pipe Size 2" and Smaller: Black steel pipe; Schedule 40; Class 150 malleable iron fittings with threaded joints.

C. Pipe Size 2-1/2" and Larger: Black steel pipe, Schedule 40, wrought-steel butt-welded fittings with welded joints. Mechanical/grooved fittings and couplings may be specified by the PSP.

2.02 Piping Specialties:

A. Provide pipe escutcheons with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish cast brass or sheet brass pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

B. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for working pressure of the piping system, with type 304, stainless steel screens. Suction diffusers with integral strainer screens may be used in tight clearance applicators with University approval.

C. Provide dielectric unions as recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

D. Sleeve Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.03 Pumps:

A. In-Line Circulator Pumps:
   1. Provide maintenance free units design for the working pressure of the piping system and 225°F continuous water temperature.
   2. Wetted surfaces shall be non-ferrous materials.
   3. Body: Cast iron with bronze or stainless steel – fitted construction.
   5. Motor: Non-overloading at any point on pump curve, open, drip-proof, oil-lubricated journal bearings, resilient mounted construction, built-in thermal overload protection on single phase motors.
   7. Impeller: Bronze or stainless steel enclosed type, hydraulically and dynamically balanced, and keyed to shaft.
B. Base-Mounted End Suction Pumps:
   1. Provide horizontal base mounted, single stage, vertical split case, flexible coupling, designed for the working pressure of the piping system.
   2. Casing: Cast iron, ANSI flanges rated for the working pressure of the piping system and tappings for gage and drain connections.
   3. Shaft: Steel with replaceable shaft sleeve.
   4. Shaft Sleeves: 316 Stainless Steel with Buna O Ring Sealing between the impeller and the hub. Threaded to tighten when rotating in normal service direction.
   5. Impeller Ring: Bronze. Easily replaceable.
   7. Seal: Mechanical Seal with ceramic seat.

C. Horizontal Split Case Pump:
   1. Provide centrifugal, single stage, base mounted, direct connected.
   2. Casing: Cast iron, ANSI flanges rated for the working pressure of the piping system, and tapping for gage and drain connections.
   4. Shaft Sleeves: Bronze or Stainless Steel.
   5. Motor: Non-overloading at any point on pump curve, open, drip-proof, oil-lubricated journal bearings, resilient mounted construction, built-in thermal overload protection on single phase motors.
   6. Impeller: Bronze
   7. Seal: Mechanical Seal with ceramic seat.
   9. Baseplate: Cast iron or steel.

D. Vertical Inline Pump:
   1. Provide centrifugal, single stage, close coupled in-line, back pullout design.
   2. Casing: Cast iron, ANSI flanges rated for the working pressure of the piping system, and tapping for gage and drain connections.
   4. Shaft Sleeves: Bronze or Stainless Steel.
   5. Motor: Non-overloading at any point on pump curve, open, drip-proof, oil-lubricated journal bearings, resilient mounted construction, built-in thermal overload protection on single phase motors.
   6. Impeller Ring: Bronze, statically and dynamically balanced, and keyed to shaft.
   7. Seal: Mechanical Seal with ceramic seat.

PART 3: EXECUTION

3.01 Pipe Testing Procedures:

   A. Refer to Appendix for hydronic pipe testing procedures.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. ANSI/ASTM B31.1 – Power Piping

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

1.03 Requirements:

A. For the purposes of this standard steam systems shall be defined as follows:
1. Low Pressure Systems: 0-15 psig
2. Medium Pressure Systems: 16-165 psig
3. High Pressure Systems: 165 psig and above

B. Provide low pressure steam via a two-parallel full capacity pressure reducing stations with 1/3-2/3 pressure reducing valves (PRV’s). No bypass shall be provided.

C. Provide a tee in the condensate receiver vent line with a 1-inch plugged branch, just above the receiver, for University installation of a high-level float switch.

D. The overflow connection at the condensate receiver should be higher than the high-level alarm but low enough to prevent condensate from backing up into the lowest-level steam traps should the condensate pumps fail.

E. Provide a plugged opening on the low side of any condensate receiver, for installation of a thermo well for future temperature sensor by the University.

F. Arrange the inlet piping to the condensate receiver so the University can dump condensate to floor drain before it enters the receiver.

G. Avoid the use of plug valves in condensate systems.

H. Provide spring-assisted, silent check valves on condensate pump discharge. Durabla SCV check valves are an acceptable option.

I. Avoid 3-1/2 and 5-inch diameter pipe.
J. Use 316 stainless steel tubing with Swagelok fittings between the discharge of all condensate pumps and the connection at the utility tunnel.

K. Provide shutoff valve between the receiver and each pump.

L. Provide power to pump motors via flexible cord (not conduit) with twist-lock.

M. Provide shutoff valves to isolate equipment, parts of systems, or vertical risers.

N. Provide high pressure steam valve 12” and larger with an equalizing bypass valve assembly.

O. Provide Flexitallic Model CG spiral-wound gaskets for steam and condensate flanged piping service.

PART 2: PRODUCTS

2.01 Steam Piping:

A. High pressure steam:

1. Piping shall be Schedule 80 seamless domestic black steel piping.
2. Fittings shall be extra heavy butt-welded type. Flanges shall be 300 lb. class welding neck type.

B. Low and Medium pressure steam:

1. Piping 1” and smaller shall be Schedule 80 black steel piping. Piping 1-1/2” and larger shall be Schedule 40 black steel piping.
2. Fittings on piping 2-1/2” and larger shall be extra heavy butt-welded type. Flanges shall be 150 lb. class welding neck type. Unions shall be 150 lb. class.
3. Fittings on piping 2” and smaller shall be screwed type, class 150 malleable black iron. Unions shall be 150 lb. class.

2.02 Steam Specialties:

A. Pressure Reducing Valves:

1. Steam pressure reducing valves shall be Spence ED (with SECO-Weld seats) or Jordan. Owner to be provided with manufacturer’s recommended repair kit for each steam pressure reducing valve. Pressure reducing valves 2 inches or larger shall be flanged and less than 2 inches shall be threaded. PRV pipe and fittings shall be Schedule 80, 300 lb. class, up to and including the first downstream block valve.

B. Steam Traps:

1. Inverted bucket traps are to be used only when the condensate outlet is subject to backpressure. When condensate flows by gravity from the trap, a float and thermostatic
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trap shall be selected. Bucket traps on high-pressure steam to be Armstrong
#213 Provide a separate gate valve installed between the trap valve station and the
steam line. Gate valves should be cast steel and rated for campus steam conditions of
165 psig at 550 degrees F. The trap station should have a gate valve off of the steam
main, pipe unions before and after the trap, a strainer with blowdown valve before the
trap, a test tee with a valve after the trap and a condensate valve downstream of the test
tee.

2. Float and Thermostatic Traps shall be ASTM A126, cast iron or semi-steel body and
bolted cover for 250 psig WSP; provide access to internal parts without disturbing
piping; with bottom drain plug, stainless steel or bronze bellows type air vent, stainless
steel or copper float, stainless steel lever and valve assembly. F&T traps used in low
pressure (15psig or less) drip applications shall be rated at 30 psig to avoid lockup in
event inlet pressure exceeds 15 psig. F&T traps used in process applications (coils and
vessels) shall be mounted at least 10’ below the process. The installation shall also
include vacuum breaker sized for the application, air vent and compound pressure
gauge.

3. Thermodynamic traps are preferred over inverted bucket traps for drip applications
above 30 psig when condensate flows by gravity to a receiver (the typical
arrangement), prevented backpressure on the trap.

4. Install Thermostatic steam traps to drain condensate from steam radiation units, and
other similar terminal heating units. Pressure balanced type with ASTM A216 WCB
cast steel body and bolted or screwed cover and integral ball joint union, for 300 psig
WSP; monel or stainless steel bellows, stainless steel valve and seat; Integral stainless
steel strainer. Freeze-proof type with cast iron body for 300 psig WSP, bronze bellows,
stainless steel valve and seat, external adjustment. Bi-metallic type with ASTM A105
forged steel body and cover, for 300 psig WSP, bi-metal element with stainless steel
components, integral Type 304 stainless steel strainer screen, and ¼ inch blow down
valve.

5. All trap station components (traps, valves, strainers) for clean steam system shall be of
316L stainless steel construction, body and trim.

C. Steam Relief Valves:
1. Relief valves 2" and smaller shall have brass bodies and arranged for screwed
connections. Such relief valves shall be Crane No. 2501 or Spirax Sarco 6010 Brass
Safety Valves for steam or approved equal. Bushings shall not be used.

2. Relief valves 2-1/2" and larger shall in the case of all medium and low pressure steam
piping systems be arranged for flanged inlet and screwed outlet connections. Such
relief valves shall be Consolidated Type 1511 or Spirax Sarco 252, ASME Standard
Cast Iron Safety Valves, or approved equal.

3. The pressure at which each relief valve shall open is designated on the Drawings. When
such valves are ordered by the Contractor, he shall definitely specify the pressure at
which each relief valve is to be set. Each valve shall have a metal tag attached stamped with the valve identification plus the pressure setting.

D. Manual Valves:

1. Low and medium pressure isolation valves shall be ball valves, Zinc plated A-105 carbon steel body and stainless steel trim, R-PTFE seats, threaded 3-piece design for pipe sizes of 2” and under (flanged for sizes above 2”).

2. High pressure Isolation valves shall be cast steel gate valves rated for campus steam conditions of 165 psig at 550 degrees F.

E. Strainers:

1. Strainers shall be A-105 or ductile iron threaded body for pipe sizes of 2” and under (flanged for sizes above 2”), rated for system temperature and pressure, 20-mesh stainless steel screen, with full-sized blow-off valve piped to drain.

2. Exception – Strainers upstream of control valves and PRV’s shall have 100-mesh stainless steel screens.

C. Air Vents and Vacuum Breakers:

1. Provide automatic air vents with a pressure rating equal to system classification, but not less than 125 psig.

2. Provide shut off valve for maintenance of the air vent.

3. Locate all air vents and their discharge lines in accessible locations, preferably clustered.

4. Mount vacuum breakers between control valve and equipment, in vertical position with cap on top, and at the highest point of the circuit.

5. Large coils or equipment may require more than one vacuum breaker.

2.03 Condensate Return Pump:

A. Condensate pumping units shall be Aurora Series 220 or approved equal condensate pumping units; bronze fitted centrifugal pumps with stainless-steel shafts and Viton mechanical seals with 1750-rpm motors and cast-iron receivers. Units shall come pre-wired with mechanical alternator. Receiver shall have thermometer and sight glass. Receiver shall have isolation valves between the pumps and the receiver. Receiver shall have a drain line to floor drain. Install condensate return pumps on housekeeping pad.
B. Pumps shall be capable of pumping against downstream head under all operating conditions.

C. Piping shall be Schedule 80 seamless domestic black steel piping.

D. Fittings on piping 2-1/2” and larger shall be extra heavy butt-welded type. Flanges shall be class 150 welding neck type.

E. Fittings on piping 2” and smaller shall be screwed type, schedule 80 steel. Unions shall be 300 lb class.

PART 3: EXECUTION

3.01 Pipe Testing Procedures:

A. Refer to Appendix for plumbing pipe testing procedures.

END OF STANDARD
PART 1 GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. Codes and Standards that are Standard at the University:
   1. SMACNA Standards: Fabricate, support, install, and seal in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible".
   3. NFPA Compliance: Install duct systems in compliance with NFPA 90A “Installation of Air Conditioning and Venting Systems”.
   5. Special Exhaust: Duct systems shall conform to NFPA 91 “Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids”

1.03 Requirements:

A. Medium and high-pressure ductwork is hereby defined as ductwork subject to operating pressures in excess of 2” w.g., positive or negative.

B. Low pressure ductwork is hereby defined as ductwork subjected to velocities of 2500 fpm or less, and operating pressure of 2” w.g. or less, positive or negative.

C. Seal ductwork to SMACNA seal Class A. All sealant shall be UL rated with NFPA flame spread of no more than 5 and smoke developed of 0.
   1. [LEED EQ Credit 4.1 Low-Emitting Materials – Specify materials that qualify as low-emitting VOC compounds as defined in the LEED Reference Guide]

D. Provide balancing dampers at supply, return, and exhaust branches when connected to larger ducts, as required, for air balancing.

E. Ductwork taps shall be conical or clinch collar with 45 degree or boot connections.

F. Connect air devices to low pressure ductwork with five-foot maximum length of flexible duct and provide with a Flex-Flow elbow support.

G. Provide long-radius elbows (R/D = 1.5) unless otherwise indicated.
H. Transition duct sizes gradually, not exceeding 20 degrees divergence and 30 degrees convergence.

I. Provide flexible duct connection on all rotating equipment.

J. Duct sizes shown on drawings shall represent the inside air stream clear area. For interior lined ductwork, upsize duct to maintain clear area inside lining.

K. Pressure class, as defined by SMACNA, shall be clearly indicated on drawings with appropriate symbols.

L. Refer to section 5.23.07 for ductwork insulation requirements.

M. For noise-prone and/or noise-sensitive applications, provide double-wall ductwork with a perforated inner liner for a minimum of ten feet after the first elbow from both supply and return plenums of the air handling unit(s). Liner shall be 2” thick, tested against erosion to at least 110% of scheduled duct velocity, and treated with an antimicrobial surface coating.

PART 2 PRODUCTS

2.01 Materials:

A. Ductwork Materials: Provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discoloration, and other imperfections, including those which would impair painting.

B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lock forming quality; with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.

C. Corrosive Fume Exhaust: Typically 304 stainless steel with welded seams unless nature of corrosive fumes require otherwise. Joints may be welded or use steel companion flange with PTFE gaskets.

D. General Exhaust: For non-corrosive, dry applications use galvanized spiral or longitudinal seamed, round duct. Slip joints with EPDM gaskets are acceptable. Review manufacturer’s information to ensure gasketing material meets process requirements.

E. Contact Molded Fiberglass Reinforced Plastic: The National Bureau of Standards "Voluntary Product Standard, PS-15-69" shall form the minimum basis for the fabrication of these FRP exhaust duct systems. Resin used shall be the Hetron 197 for its fire retardant and corrosion resistant properties.

F. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction rated to two (2) inches WG positive and 1.5 inches WG negative for low pressure ducts. Flexible duct shall be wrapped with flexible glass fiber insulation, enclosed by
seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.


PART 3 EXECUTION

3.01 Installation of Ductwork:

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable braces, and anchors of type which will hold ducts true-to-shape and to prevent buckling.

B. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate. Provide fire or fire-smoke dampers as required by Code.

3.02 Testing:

A. Medium Pressure Leakage: After medium pressure duct system is constructed, test for duct leakage in accordance with the latest versions of ASHRAE 90.1 and SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than 1% of system design airflow when the system is pressurized to the design duct pressure class rating.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. Codes and Standards that are Standard at the University:
   1. AMCA 210 and 300: Centrifugal fans must be licensed to bear the AMCA Certified Ratings Seal for both air and sound. Sound rate centrifugal fans in accordance with the latest version of AMCA 300 “Test Code for Sound Rating Air Moving Devices”.
   2. AMCA 204: Balance Quality and Vibration Levels for Fans
   3. ASHRAE Compliance: Test and rate centrifugal fans in accordance with the latest version ASHRAE 51 (AMCA 210) “Laboratory Methods of Testing Fans for Rating”.
   4. UL Compliance: Provide centrifugal fan electrical components which have been listed and labeled by UL.

1.03 Requirements:

A. Fans shall be selected with minimum 75% fan efficiency at design operating point. In all cases, the PSP shall evaluate system conditions and select the optimum fan type and configuration based on efficiency, system curve, and fan characteristics at all anticipated design conditions.

B. Fans shall be dynamically balanced and factory-tested in accordance with AMCA 204-96 at the design operating RPM to Fan Application Category BV-3, Balance Quality Grade G6.3.

C. Design resonant speed of fan system (not critical speed) shall be minimum 25% greater than its maximum operating speed.

D. Air handling fan preference shall be double width, double inlet with backward inclined centrifugal airfoil blades. Plenum type plug fans required approval from the University.

E. Fans greater than 5,000 shall be rigidly mounted to floor with no vibration isolators. The fan shall be dynamically balanced and tested at the factory such that displacement does not exceed 1.5 mils peak to peak in any direction. Typical spring isolators may be specified with University approval.
F. Provide epoxy coating finish as a minimum with additional protective coatings on fans as required by project conditions.

G. Provide AMCA spark resistant construction option: A, B, or C as required by project conditions.

H. Refer to 5.23.05 for fan vibration control requirements.

I. Provide heavy-duty, grease-lubricated, precision anti-friction ball or roller, self-aligning, bearings selected for minimum average life (AFBMA L10) of 200,000 hours.

J. Provide V-belt drive, selected for 1.2 service factor for fractional horsepower motors and 1.4 service factor for motors 1 horse power and above. Include belt guard with cutout for reading shaft RPM. Fixed sheaves shall be matched and sized for minimum 2x the NEMA rating.

K. Provide open drip-proof NEMA Premium Efficiency rated motor rated for compatibility with variable frequency drives where applicable. Select non-overloading motors at all points on the RPM operating curve.

L. Shafts shall be constructed of AISI grade 1040 or 1045 solid hot-rolled steel, turned, ground, and polished. The shaft’s first critical speed shall be at least 125% of the fan’s maximum operating speed.

M. Provide accessories per the following requirements where specified:
   1. Access Doors: Provide access door in scroll housing, with latch-type handles, flush mounted for un-insulated housings, and raised-mounted for insulated housings.
   2. Backdraft Dampers: Provide gravity-actuated dampers on fan discharge, counterweighted, with interlocking aluminum blades with felt edges in steel frame
   3. Drain Connections: Provide minimum 3/4 inches threaded coupling drain connection at lowest point of housing.
   4. Extended Grease Lines: Extend grease lines from bearings to outside of inlet duct flange, terminate with grease fitting.
   5. Heat Slingers: Provide metal disc between bearings and fan wheel, to dissipate heat from shaft.
   6. Split Housings: Provide flanged, horizontally split housings as required by project conditions.
   7. Weather Hoods: Provide protective weather hood with stamped vents over motor and drive compartment.
      a. Screens: Provide heavy mesh removable screens on fan inlet and outlet.
      b. Fan Guards: Specify guards on inlets and outlets not connected to ductwork, constructed of expanded metal in removable frame
PART 2: PRODUCTS

2.01 Centrifugal Fans, Steel (General Application):

A. Provide centrifugal fans built to Class II construction (minimum).

B. Provide factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings, and side support structure.

C. **Housings:** Provide curved scroll housings; lockseam construction for sizes 24 inches to 40 inches, spot welded construction for sizes 44 inches to 60 inches, and continuous weld construction for sizes 66 inches and larger. Provide horizontally split housings, bolted together for sizes 66 inches and larger. Provide spun inlet cones and duct connections.

D. **Wheels:** Provide backwardly inclined plate-type blades for sizes 22 inches and smaller, non-power-overloading backwardly inclined airfoil blades for sizes 24 inches and larger. Weld blades to wheel rim and hub plate. The wheels shall be backward inclined. Key wheels to shafts.

2.02 Centrifugal Fans, Fiberglass Reinforced Plastic (Corrosive Applications):

A. **Fan Units:** Provide factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings, and fan support stand. The exterior of the fan housing shall be coated with an industrial grade gel coat, free from surface imperfections, a pigment to achieve the desired color and an inhibitor to prevent ultra-violet degradation.

B. **Housings:** Construct sections with flange joints utilizing stainless steel bolts and appropriate gasketing. The resins used to fabricate the fan housing shall be premium grade, fire retardant and selected for chemical environment. The fiberglass reinforcement shall be an industrial commercial grade of glass mat or woven roving, such as manufactured by Owens-Corning and shall have a suitable coupling agent to provide a bond between the glass reinforcement and the resin.

C. **Wheels:** Provide with a cast iron back plate or imbedded hub in the wheel and keyed to a polished steel shaft.

2.03 Utility Fans:

A. **Fan Units:** Provide factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings, and fan drive.

B. **Housings:** Construct of heavy-gage steel with side sheets fastened to scroll sheets by means of deep lock seam. Provide round inlet collar, slip joint discharge duct connection. Construct housings to be convertible to 8 standard discharges. Provide adjustable motor supports.
C. Wheels: Provide forward curved or backward inclined wheels as scheduled. Provide swaged hubs.

2.04 Tubular Centrifugal Fans:

A. Fan Units: Provide factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings, straightening vanes, and motor support. Clean, condition, and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.

B. Housings: Construct housings of low carbon steel with continuous-weld construction, braced to prevent vibration or pulsation. Provide streamlined inlet and outlet configurations.

C. Wheels: Provide airfoil type blades and welded construction. Statically and dynamically balance wheels before assembly, and balance again in assembled unit at design rpm.

2.05 Inline Centrifugal Fans:

A. Housing: Aluminum split housing, constructed of spun aluminum, with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

B. Direct-Drive Units: Specify ball bearing motor encased in housing so as to be out of air stream. Provide factory wiring to disconnect located on outside of fan housing.

C. Belt-Drive Units: Request ball bearing motor mounted on adjustable base. Provide enclosure around belts. Provide lubricating tubes from fan bearings to outside of fan housing.

D. Wheel: Aluminum airfoil blades on aluminum hub.

2.06 Vane Axial Fans:

A. Fan Units: Provide factory-assembled and tested fan units consisting of housing, propeller and hub, fan shaft, bearings, and fan drive.

B. Housing: Shall be constructed of steel with welded construction or corrosion resistant fasteners.

C. Propeller: Shall be adjustable pitch with cast aluminum blade.

END OF STANDARD
23 36 00 – AIR TERMINAL UNITS
DESIGN AND CONSTRUCTION STANDARD

PART 1 - GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. Base acoustic performance of terminal units upon units tested according to ARI 880 and ASHRAE Standard 130.

B. Base occupied space sound level estimates on ARI 885.

C. Terminal heating coils shall conform to ARI 410.

1.03 Requirements:

A. Base acoustic performance of terminal units upon units tested according to ARI 880 and ASHRAE Standard 130.

B. Provide unit with single point electrical connection

C. Electric actuators shall be sized appropriately with specified control type and manufactured by Belimo.

D. The damper shafts shall be round and operate in Sintered Bronze self-lubricating bearings. The end of the shaft at the operator end shall be scored in line with the damper blade to reference the damper blade position.

PART 2 - PRODUCTS

2.01 Single Duct Variable Air Volume Units:

A. Units shall be capable of controlling air volume to within plus or minus 5% of air volume setpoint, as determined by the zone temperature sensor demand with variations in inlet pressures from 0.10” to 6” w.g.

B. Units shall have internal air resistance, including hydronic heating coil, not to exceed 0.4” w.g. at maximum flow.

C. Provide external differential pressure taps separate from the control pressure taps for airflow measurement with a 0”-1”w.g. range.
D. Select units at maximum 2,000 FPM and minimum 400 FPM inlet velocity with unit discharge and radiated sound power levels such that occupied space Noise Criteria does not exceed NC-30 per ARI 885.

E. Units shall be constructed with minimum 22 gauge galvanized steel enclosures.

F. Casing Leakage: Assembled units shall be so constructed and sealed to limit air leakage to the following listed quantities at 3" static pressure. If sealing is required to obtain the leakage performance, seal as for medium pressure ductwork Hardcast 1602 or FOIL-GRIP 1402 tape may be used to seal lap joints and flat seams only. Leakage curves or tables will be required as part of the submittal data. The following is the maximum allowable casing leakage including all components:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Maximum Allowed CFM (Area x 2000 fpm)</th>
<th>Maximum Allowable CFM Casing Leakage</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”-5”-6”</td>
<td>393</td>
<td>8.0</td>
</tr>
<tr>
<td>7”-8”</td>
<td>698</td>
<td>14.0</td>
</tr>
<tr>
<td>9”-10”</td>
<td>1091</td>
<td>22.0</td>
</tr>
<tr>
<td>11”-12”</td>
<td>1571</td>
<td>30.0</td>
</tr>
<tr>
<td>13’-14”</td>
<td>2138</td>
<td>40.0</td>
</tr>
</tbody>
</table>

G. The following is the maximum damper leakage allowable for the various size diameter inlets. The damper leakage shall not exceed the values listed in the table below at 6” w.g. differential pressure, following ARI 880 Testing Procedures.

<table>
<thead>
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</tr>
<tr>
<td>13’-14”</td>
<td>2138</td>
<td>30.0</td>
</tr>
</tbody>
</table>

H. Provide minimum 3/4” internal lining with all edges sealed against airflow erosion in accordance with NFPA 90A and UL 181.

I. Unit air volume shall be set at factory and provided such that special tools are not required for field adjustment.

J. Power to and within terminal unit shall be 24 volts.

2.02 Fan Powered Variable Air Volume Units:

A. Units shall be capable of controlling air volume to within plus or minus 5% of air volume setpoint, as determined by the zone thermostat demand with variations in inlet pressures from 0.10” to 6” w.g. Fan powered Variable Air Volume Units allowed only with Owner’s approval.
B. Units shall be constructed with minimum 20 gauge galvanized steel enclosures.

C. Damper (air valve) shall have a leakage rate of less than 2% of the box’s maximum scheduled CFM at two times primary supply air duct static pressure or 3” w.g. (whichever is smaller).

D. Provide minimum 3/4” internal lining with all edges sealed against airflow erosion in accordance with NFPA 90A and UL 181.

E. Fans in parallel terminal units shall be forward curved, centrifugal, direct-drive motor with SCR controller for airflow adjustments from 60%-100%. The SCR controller and fan motor shall be harmonically balanced to reduce electrical noise.

F. Fans in series terminal units shall be forward curved, centrifugal with direct-drive electronic commutated motors (ECM).

G. Fan and motor assembly shall be internally suspended and isolated from the casing on rubber in shear isolators. Fan and motor assembly shall be easily accessible through access panels without disassembling the entire unit. Fan assembly shall include an anti-backward rotation device.

H. All primary power to fan powered boxes shall be 120 volts.

2.03 Terminal Heating Coils:

A. Shall be hot water fin and tube type constructed of seamless copper with aluminum fins mechanically bonded to the tubes and copper headers.

B. Casing and tube supports shall be minimum 16 gauge galvanized steel.

C. Coils shall be drainable, suitable for 250 psig working pressure, with circulated tubes factory tested at not less than 300 psig air pressure.

2.04 Dual Duct Terminal Units (UT Mixing Laterals):

A. Dual duct systems, either existing or justified through LCC, may utilize UT standard mixing laterals for zone temperature control. Refer to UT Standard Details

B. Damper casings shall be constructed of 18 ga. galvanized sheet metal, sized with female connections each end.

C. The damper blades shall be 16 ga. cold rolled, galvanized steel and shall be spot welded to shaft.

D. Dampers shall be Arrow Model 70-UTA.
E. Electric actuators shall be furnished, mounted and adjusted by the BAS contractor. Terminal volume damper manufacturer shall provide mounting base on terminal unit for mounting of actuator. Actuator shall be sized for specific application with a minimum torque of 40 in-lb. and shall utilize a brushless motor. Housing shall be designed for reversing rotation. Actuator shall be proportional control, 0-10V, spring return with maximum run time of 150 seconds and spring return time of less than 60 seconds. Maximum power draw of actuator shall be 10VA. All actuators installed throughout project shall be of the same manufacturer and model.

F. Electric actuators shall be sized appropriately with specified control type and manufactured by Belimo or approved equal.

2.05 Dual Duct Terminal Units (Manufactured):

A. Dual duct systems, either existing or justified through LCC, may utilize factory fabricated terminal units for zone temperature and air flow control.

B. Provide factory-assembled, externally powered, variable air volume control terminal. Unit shall be complete with a damper assembly, flow sensors, externally mounted volume controllers, collars for duct connection and all required features. Control box shall be clearly marked with an identification label that lists such information as nominal cfm, maximum and minimum airflow limits.

C. Damper casings shall be constructed of 22 ga. galvanized sheet metal with round inlet collars and rectangular discharge with slip and drive connection.

D. The damper blades shall be heavy gage, galvanized steel and shall be spot welded to shaft. Damper blade shall incorporate a flexible gasket for tight airflow shutoff.

E. Cabinet shall be insulated with closed cell elastomeric insulation, high density fiberglass insulation with fiber reinforced mat facing, or rigid board insulation with fiber reinforced foil facing. Provide full seam Z-strips to enclose the insulation edges. Insulation shall meet NFPA-90A requirements for flame spread and smoke generation and UL-181 requirements for anti-erosion, corrosion and fungus properties.

F. Units shall have pressure-independent electronic controls, as specified, capable of maintaining required airflow set points +/-5% of the unit’s capacity at any inlet pressure up to 6-in. wg., when measured at either inlet duct. The unit shall be equipped with an amplified flow probe located in the cold deck inlet and the cabinet discharge. Air flow rate shall be determined with a factory supplied 12 point total pressure, center averaging cross flow sensor. Electric actuators shall be furnished by the BAS contractor and installed by the manufacturer at the factory. All actuators installed throughout project shall be of the same manufacturer and model. Electric actuators shall be sized appropriately with specified control type and manufactured by Belimo or approved equal.

G. Unit supplied shall be rated in accordance with ARI 880 certification program at the rated flow rates and pressures. The unit manufacturer shall furnish octave band sound power data for both casing radiated and discharge sound levels with the selected lining and above flow
sensor, as tested per ARI Industry Standard 880-98, at the required flow rates and inlet pressures.

H. Power to and within terminal unit shall be 24 volts.

PART 3 EXECUTION

3.01 Installation:

A. Maintain NEC and manufacturer’s recommended clearances for control enclosures.

B. Provide manufacturer’s minimum straight duct inlet requirements.

END OF STANDARD
23 40 00 - HVAC AIR CLEANING DEVICES
DESIGN AND CONSTRUCTION STANDARD

PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. Codes and Standards:

1.03 Requirements:

A. Provide area for removal of pre-filter from upstream of airflow and final filter from downstream of airflow.

B. Indicate on drawings filter requirements, single or dual. Only filter sizes of 24” x 24” and 24” x 12” are acceptable. Recirculating units shall typically require single filter bank.

C. Provide dual filter arrangement on dedicated outside air units.

PART 2: PRODUCTS

2.01 Filters:

A. Filter Section (Dual Filter Bank): Provide filter sections to allow for 2” thick, pre-filter, dry type, moderate efficiency, MERV 8, disposable filters with 100% synthetic media. Provide 12” - 24” deep, high efficiency, MERV 13 final filter. Final filter can be bag or box type and shall be 100% synthetic media.

B. Filter Section (Single Filter Bank): Provide flat filter sections with hinged access doors on each end of the section. Furnish 2” minimum thickness, dry type, moderate efficiency, MERV 8, disposable filters with 100% synthetic media.

2.02 Housings:

A. Shall be provided by air handling unit manufacturer. Provide access doors on each side of section. Provide gasketed galvanized steel filter blanks to prevent air bypass around filter.

END OF STANDARD
PART 1 - GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

B. ARI Standard 400 for Liquid to Liquid Heat Exchangers.

1.03 Requirements:

A. Provide shell and tube type heat exchangers with removable tube bundles.
B. Provide dielectric fittings on heat exchanger water connections.

PART 2 – PRODUCTS

2.01 Steam to Heating Hot Water Converters:

A. Provide converters of shell and U-tube type, steam in shell, 100 psi minimum steam working pressure, 150 psi water pressure, conforming to ASMD Code and Unfired Pressure Vessels.
B. Tubes material shall be copper or stainless steel.
C. Provide two pass heat exchanger with water velocity approximately 4.0 fps.

2.02 Water to Water Heat Exchangers:

A. Provide ARI 400 certified plate and frame type heat exchanger rated for working pressure of hydronic system.
B. Provide with type 304 stainless steel plates and plate hangers. Frame shall be carbon steel with epoxy corrosion resistant finish.

END OF STANDARD
PART 1: GENERAL

1.01 General:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

B. UT Austin desire is to ensure that all new refrigeration equipment delivered to campus conforms with EPA guidelines for refrigerants and is serviceable by UT Austin Maintenance Department. The goal is to have equipment provided that is designed for and provided with final replacement HFC refrigerants.

C. UT Austin desire is to standardize on refrigerant types as a means for minimizing the number of refrigerants in inventory. To accomplish this only selected refrigerants are acceptable.

D. Areas where large quantities of refrigeration are to be stored or used shall be provided with local alarm annunciation, ventilation systems and signage.

E. It is the intent that all refrigeration equipment by 100% serviceable by UT maintenance personnel. Exotic refrigeration systems that require specialty service equipment, refrigeration charges, or other non-standard components are not acceptable without prior approval by UT Austin Maintenance Department.

1.02 Design:

A. UT Austin desire is to have condensing equipment located as close as possible to evaporator.

1. Environmental Chambers. Where refrigeration equipment is used, condensing equipment shall be located at the chamber. Ventilation shall be provided for removal of heat from condensing unit. Adequately sized access and egress to condensing equipment shall be provided for preventative maintenance and removal of equipment. Refrigeration piping shall be designed for return of oil to compressor location. Exceptions may be approved by owner for large loads on a case-by-case basis. In such cases, owner shall approve locations of condensing compressor.

B. Low and ultra-low temperature refrigeration shall be accomplished with multiple compressors. Refrigerant for each compressor/evaporator circuit shall be independent and of types listed below. Auto-cascading refrigerant circuits are not acceptable.

PART 2: PRODUCTS

2.01 General:
A. The refrigerants listed in this section comply with EPA guidelines as final HFC refrigerants and conform to UT Austin inventory requirements.

B. Manufacturer specialty refrigerant blends, refrigerant charges available only from the original manufacturer or refrigerant requiring special ordering are not acceptable.

2.02 Acceptable HFC Refrigerant Types and Application:

A. **R134a** (replaces R12). Medium temperature applications. Packaged refrigeration and air conditioning equipment.

B. **R404a** (replaces 502). Medium and low temperature applications. Reach-in and walk-in coolers and freezers, environmental chambers.

C. **R404a** high stage with **R23** (replaces R13, R502, R503), Ethane or Propane low stage. Multi-stage low and ultra-low temperature applications. Reach-in freezers.


1. [LEED EA prerequisite 3 Refrigeration Management – Zero use of CFC-based refrigerants in new base building HVAC&R systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion prior to project completion.]

2. [LEED EA credit 4 Enhanced Refrigerant Management - Select refrigerants and HVAC&R that minimize or eliminate the emission of compounds that contribute to ozone depletion and global warming AND do not install fire suppression systems that contain ozone-depleting substances (CFCs, HCFCs or Halons).]

**PART 3: EXECUTION**

3.01 Refrigerant Removal:

A. Open discharge of refrigerants is not acceptable. All refrigerants shall be recovered utilizing appropriate recovery equipment and in accordance with current regulatory guidelines.

B. Refrigeration equipment scheduled for demolition and removal shall have refrigerant charge removed. Technician performing removal shall be licensed under the State of Texas for such work. Technician shall provide statement indicating that refrigerant has been removed. Statement shall include date of removal, printed and signed name of technician, license number of technician and type of refrigerant removed. Statement shall be affixed to equipment with copy included with final project documents.

**END OF STANDARD**
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

A. Codes and Standards:
   1. ARI 410 – Standard for chilled water, hot water and steam coils
   2. ARI 430 – Central Station Air Handling Units
   3. AMCA 99 – Standards Handbook
   5. AMCA 300 – Test Code for Sound Rating Air Moving Devices
   6. AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices
   7. AMCA 500 – Test Methods for Louver, Dampers, and Shutters
   8. ASTM D4230 – Measuring Humidity with Cooled Surface Condensation
   9. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems

1.03 Requirements:

A. Air Handling Units shall be designed to the specific requirements of the application: Recirculation or 100% Makeup.

B. Test and rate chilled water, hot water and steam coils in accordance with ARI 410. Display certification symbol on units of certified models.

C. Do not operate air handling systems for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation of representative.

D. Air Handler fabrication shall conform to AMCA 99 and ARI 30 in the absence of direction in this standard.

E. Provide air handling unit internal insulation having maximum flame spread rating of 25 and maximum smoke developed rating of 50.

F. Provide air handler casings design, manufactured, and installed such that no condensation shall form on the exterior or interior surfaces (other than on cooling surfaces), including joints and seams.
G. University preference is for factory built air handling units. If project conditions require, built-up air handling units may be used, but must be justified through LCC analysis and be approved by the University.

PART 2: PRODUCTS

2.01 Air Handler Casings (Factory):

A. General: Provide horizontal or vertical type factory-fabricated air handling units as indicated, of sizes and capacities as scheduled, and as specified herein.

B. Construction: Each unit shall have a double wall airtight and weatherproof casing and shall be sectionalized for placement (indoors or outdoors) for all internal components. For units located in un-air-conditioned rooms, provide a welded, full perimeter structural or tubular steel base frame with intermediate supports for all internal components. Provide thermal break construction between exterior panel and frame. Unit casings shall be insulated internally to provide minimum R-13 thermal resistance. Provide double bottom floor construction minimum R-13 thermal resistance and full walk-on interior non-skid surface.

C. Performance: Unit casing shall be constructed, assembled, and factory tested to withstand operating pressure of 1.5 times the operating pressure or 6 inches w.g. positive (whichever is greater) with a maximum leakage rate of 1% of total airflow and deflection of 1/200th of the panel width or height.

D. Coil Section: The coil section shall completely enclose the coil headers and return bends. Coil frames shall not be used as structural members of the coil section. The coil section shall be constructed in such a manner that the coils can be removed without affecting the structural integrity of the casing.

E. Condensate (fin water) Drain Pan: Provide drain pans that meet all requirements of the latest version of ASRHAE 62.1. The drain pan shall be insulated, double wall type constructed of 304 stainless steel inner pan with stainless steel drain nipples and a galvanized, or painted, outer pan. Provide drain pans with 1 inch thick, 3 pound per including headers, and shall be rigid and watertight and sloped in 2 planes to accessible side of unit. Provide minimum 1-1/2 inches male NPT cubic feet insulation between inner and outer pans. The drain pan shall extend under the complete cooling coil, hot water coil, steam coil, and humidifier section, stainless steel pipe drain connections extending 2 inches beyond the outside wall of the unit casing, or with drain connections as indicated on drawings. Drain pans shall not recess into floor of casing. Provide drain pans extending a minimum 24 inches downstream of coils, and provide downsputs and intermediate condensate collectors for stacked coil banks. Pans shall not be recessed into unit casing. Refer to 5.22.20 Water Recovery for fin water recovery and piping requirements.

F. Access: Provide double wall insulated walk-in access doors with full perimeter gaskets in each casing section. Provide doors with windows, continuous stainless steel hinges,
and quick opening handle with locking latch. Doors shall be 24 inches wide and full height of wall panel or maximum 72 inches tall, except where indicated otherwise on drawings. 18” wide access doors may be considered for space considerations where approved by the University.

G. **Filter Gauges:**
   1. Provide surface mounted magnahelic gauge for each prefilter and final filter bank, with integral leveling screw and graduated to read appropriate pressure range based on maximum dirty filter pressure loss.
   2. Provide pressure tips, tubing, gauge connections, and mounting bracket.

2.02 **Air Handler Casings (Built-up):**

A. Assembled casing shall be double wall, airtight, with minimum 16 gauge thickness galvanized steel outer wall insulated throughout with minimum R-15 insulation. Inner wall shall be solid galvanized sheet metal, of a minimum of 18-gauge thickness. There shall be a thermal break between all inner and outer panels. Panels should be minimum 4” thick.

B. Provide drain pans that meet all requirements of the latest version of ASRHAE 62.1. The drain pan shall be insulated, double wall type constructed of 304 stainless steel inner pan with stainless steel drain nipples and a galvanized, or painted, outer pan. Provide drain pans with 1 inch thick, 3 pound per cubic feet insulation between inner and outer pans. The drain pan shall extend 12 inches downstream of cooling coil and shall also extend under complete hot water coil, steam coil, and humidifier section, including headers, and shall be rigid and watertight and sloped in 2 planes to accessible side of unit. Provide minimum 1-1/2 inch male NPT stainless steel pipe drain connections extending 2 inches beyond the outside wall of the unit casing, or with drain connections as indicated.

2.03 **Casing Section:**

A. Casing Section shall have a complete perimeter channel base of at least 6 inches concrete pier or 6 inches galvanized steel, or 6 inches carbon steel with marine quality primer. All floors shall be insulated with minimum R-13 insulation with 16-gauge non-skid galvanized floor. An 18 gauge galvanized sheet shall enclose drawings. Drain pans shall not recess into floor of casing. Provide drain pans extending a minimum 24 inches downstream of coils, and provide downspouts and intermediate condensate collectors for stacked coil banks and form a vapor barrier for the insulation on the bottom of the unit. All points of contact between the floor, vapor barrier and structure shall be thermally isolated with gasketing of closed cell soft rubber or EPDM.

B. **Access doors** shall be provided to allow access to both sides of all coils. Access doors shall be double wall, insulated, and the opening framed. Door size shall be at least 24 inches wide and full height of the panel up to 5'0 inches tall with a minimum of 8 inch by 6-inch double glazed view window, capable of withstanding the total developed pressure of the unit. All access doors shall open against air pressure, unless approved
by the owner in writing. All doors opening outward of casing shall have heavy-duty pull handles separate from latches.

C. **Panels** shall be double wall, reinforced construction with sufficient internal bracing to prevent excessive deflection of the panels. Unit casing shall be constructed and assembled to withstand operating pressure of up to 6 inches w.g., or 150% of design S.P. of supply fan, whichever is greater, positive with a maximum leakage rate of 1.5% of total airflow and deflection of 1/250th of the panel width or height

1. **Minimum Casing Sound Transmission Loss (dB) per ASTM E-90 & E-413.**
   a) Octave 2 3 4 5 6 7 STC+
   b) Perf Liner 22 26 37 44 53 55 39
   c) Solid Liner 22 38 49 50 57 62 42

2. **Minimum Casing Sound Absorption Coefficients per ASTM C-423 & E-795.**
   a) Octave 2 3 4 5 6 7 NRC+
   b) No liner .26 .71 1.09 1.02 .96 .83 .95
   c) Perf Liner .25 .79 1.06 1.06 1.04 .78 1.00

3. Full sound performance data shall be submitted to the Project sound consultant for evaluation. Unit shall be finally configured so as to not exceed the room NC values as recommended in ASHRAE HVAC Applications.

2.04 **Chilled Water Coils: (100% Makeup)**

A. Chilled water coils shall meet all conditions and have the minimum face area and pressure drops scheduled on the Drawings, and shall have same-end supply and return connections unless otherwise indicated.

1. Coils shall be constructed of seamless, hard-drawn copper tubes 5/8 inches O.D. with 0.035 inches thick minimum wall thickness.
2. Continuous, flat, unenhanced plate type copper fins permanently bonded to the tubes by mechanical expansion of the tubes. Coil assemblies shall be maximum 6 rows deep. Coils shall have maximum 8 fins per inch. Fins shall be 0.010 inches thick copper.
3. Fins shall have full drawn collars to provide continuous surface cover over the entire tube surface such that no bare copper tube is visible between fins.
4. Return bends on coil tubes shall be full size, seamless copper tubing with .025 inch wall thickness. Coil tubes shall be 1-1/2 inches center-to-center distance with adjacent rows staggered one half the pitch distance, i.e., 3/4 inches.
5. Coils shall be counterflow, single-circuit, and serpentine with full face-feed headers. Coil headers shall have splayed connections.
6. Water coils shall be circuited for complete drainability.
7. Internal tube baffles or turbulators are not acceptable.
8. Internal tube grooves or riflings are not acceptable.
9. Stacked coils shall be independently demountable and supported on internal racks
10. Face velocity shall be – 375-425 f.p.m at unit design airflow.

B. Coil headers shall be of heavy gauge seamless hard drawn copper tubing.

C. Supply and return connections shall be of Schedule 80 extra heavy, Alloy 85 red brass pipe terminated with male National Pipe Threads and shall be arranged with supply at the bottom, return at the top and separate vent and drain openings.
D. Coil connections or nozzles shall be of the same diameter, (or larger), as the coil headers.

E. Each coil assembly shall have factory installed drain and vent connections.

F. Coil casings shall be constructed with end flanges of sufficient depth to extend beyond and completely protect tube U-bends. The coil casing shall be constructed entirely of type 304 stainless steel, minimum 16 gauge. Intermediate tube support sheets shall be provided in all coils having tube lengths in excess of 60 inches and on long coil sections the spacing of coil supports shall be equally spaced and not exceed 60 inches. All bolts, washers, lock washers, nuts, and other fasteners, brackets, or supports shall be stainless steel.

G. Maximum tube length shall not exceed 156 inches. Maximum Fin Length shall not exceed 48 inches.

H. Coils shall be removable from end panels with blank-off sheets and sealing collars at connection penetrations.

I. The complete coil core shall be under warm water to a pressure of 315 psig and be suitable for operation at 250 psig working pressures.

2.05 Chilled Water Coils: (Recirculation)

A. Chilled water coils in recirculating units shall be the same as 100% makeup units with the following exceptions:
   1. Aluminum fins are acceptable.

2.06 Hot Water Coils: (100% Makeup)

A. Hot water coils shall be constructed the same as chilled water coils except they shall be two row and shall use a minimum 16 gage galvanized material for casing construction. Fins shall be 0.010 inches thick minimum.

B. Face velocity to be no greater than 500 f.p.m.

2.07 Hot Water Coils: (Recirculation)

A. Hot water coils in recirculating units shall be the same as 100% makeup units with the following exceptions:
   1. Aluminum fins are acceptable.

2.08 Steam Coils:

A. Steam coils shall be non-freeze, self-draining type and meet all conditions of minimum face area and pressure drops as scheduled on the Drawings.
1. Coils shall have same-end supply and return connections unless vertical tube coils are used.
2. Coil outer tubes shall be constructed of seamless, hard-drawn copper tubes, 1 in. O.D. with 0.049 inch minimum wall thickness. Coil inner steam distribution tubes shall be 5/8 in. O.D. seamless, hard-drawn copper tubes having a 0.25 inch minimum wall thickness.
3. Coils shall have fins fabricated of 0.010 inches thick aluminum. Tubes to be 3 inches center-to-center spacing.
4. Steam coils shall be one row deep with six fins per inch, unless required otherwise by application.
5. Coil headers shall be of heavy gauge seamless hard drawn copper tubing with penetrations for connection of core tubing by die-formed intrusion process.
6. Supply and return connections shall be of Schedule 80 extra heavy Alloy 85 red brass pipe and shall be terminated with male National Pipe Threads.
7. The coil end opposite the connection end shall be free to float within the casing as expansion and contraction occurs and, as a result of this thermal movement, shall not pass through a header end sheet at any time.
8. The supply header shall be encased in the return header and shall feed the inner steam distributing tubes.
9. Orificed baffle plates shall be installed in the supply headers opposite the supply connection to ensure proper diffusion of the entering steam.
10. Face velocity to be no greater than 600 fpm.

B. Each coil section shall be provided with a casing constructed of continuous galvanized steel, minimum 16 gauge. Coil side plates shall be reinforced flange type and shall have 3/8 inches x 3/8 inches slots on 6 inches centers for mounting. Full-length fin channels shall be furnished to brace the coil core at not more than 60 inches centers. The complete coil shall be tested under warm water to a pressure of 315 psig and guaranteed for 150 psig working pressures.

C. After every steam trap used on steam coils shall include a test valve and then a block valve for maintenance.

2.09 Fans:

A. Refer to Section 5.23.34 for fan requirements.

2.09 Motors and Drives:

A. Refer to Section 5.23.05 for motor requirements. Motors shall be mounted to be accessible and removable through the casing access door.

2.10 Filters:

A. Refer to Section 5.23.40 for requirements.

2.11 Finishes:
A. Provide galvanized surface finish as minimum. Provide paint or special coatings as required by project conditions.

PART 3: EXECUTION

3.01 Installation:

A. Install coils in compliance with The University of Texas Drawing Details.

B. Provide minimum of 36 inches between coils in air handling units for service.

C. Install in conformance with manufacturer’s instructions and ARI 435.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:


C. ICEA S-95-658 / NEMA WC70 – Nonshielded 0-2kV Cables.

D. IEEE STD-802.3 - Carrier Sense Multiple Access with Collision Detection Access Method and Physical Layer Specifications.

E. IEEE STD-1202 – Flame Testing of Cables for Use in Cable Tray In Industrial and Commercial Occupancies.

F. NEMA 250 – Enclosures for Electrical Equipment (1000Volts Maximum).


D. TIA/EIA-455-25B - Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies.

E. TIA/EIA-455-41A - Compressive Loading Resistance of Fiber Optic Cables.

F. TA/EIA-455-59 - Measurement of Fiber Point Defects Using an OTDR.

G. TIA/EIA-455-104A - Fiber Optic Cable Cyclic Flexing Test.


K. UL-44 - Thermoset-Insulated Wires and Cables.

L. UL-1277 - Electrical Power and Cable Tray Cables with Optional Optic Fiber Members.
M. UL-2024 - Optical Fiber Cable Raceway.

1.03 Requirements:

A. Provide cables and tubing suitable for the installed service conditions.

B. Preferred configuration for instrumentation cables are home runs from instrument to final termination on an I/O nodule.

C. Where there are numerous instruments in an area it will be permitted, at UT discretion, to group instruments and control circuit signals in a multiple pair (instruments) or conductor (control) cable.

D. Provide instrument and control cables for multiple equipment with spare conductors or pairs. For example, for a control circuit that requires 5 conductors provide a 7 conductor cable; for a multiple instrument cable provide 6 pair if total number of installed instruments are 4.

E. Provide identification labels for cable and individual conductors.

F. Provide protection for materials during shipment and storage prior to installation.

PART 2: PRODUCTS

2.01 Instrument Cable:

A. 300 V or 600 V shielded multi-conductor cables shall be suitable for operation in instrument circuits carrying low level digital and analog signals.

B. Sunlight resistant and suitable for installation in wet or dry locations, whether in tray, conduit or underground duct, both indoors and outdoors.

C. Conductor size of No. 18 AWG annealed copper with Class B stranding; tinned copper or alloy-coated as required to be compatible with material in contact with them.

D. Insulation rated for 300 V or 600 V and continuous operation at a 90° C conductor temperature. Insulation shall be free stripping from the conductor material.

E. Each pair or triad shall consist of individually insulated conductors twisted together with a drain wire and covered with a shield and jacket. Drain wire to be 20 AWG, Class B stranded tinned copper wire in accordance with ASTM B 33. Maximum lay of twist to be three inches.

F. Shielding shall consist of a minimum 2 mil thick laminated, non-burning aluminum Mylar tape applied helically with the aluminum side in continuous contact with the drain wire. A minimum 15 percent overlap is required in the shield tape lay to ensure 100 percent coverage.
G. Jacket material shall be suitable for installed service conditions and flame resistant, oil, heat, moisture, weathering, abrasion and chemical resistant

H. Color coding to be as follows.
   1. Pairs: One conductor Black and one White.
   2. Triads: One conductor Black, one White and one Red.

I. Individual conductors shall pass the VW-1 vertical wire flame test of UL 44. Completed cables shall pass the vertical tray flame propagation test in accordance with IEEE1202 or UT approved equal utilizing heat from a 70,000 BTU per hour burner

2.02 600V Control Cable:

A. The multi-conductor cable shall be suitable for operation in either 125 volt DC, 240 volt AC, or 120 volt AC, 60 hertz, control and signaling circuits. Cables shall also be rated for potential and current transformer circuits.

B. The cable shall be sunlight resistant and suitable for installation in wet or dry locations, whether in tray, conduit or underground duct, both indoors and outdoors.

C. Cable materials, construction and testing shall meet or exceed the requirements of ICEA S-95-658.

D. Conductor material shall be No. 14, 12 or 10 AWG annealed copper with Class B stranding, as required based on current capacity. The conductors shall be tinned copper or alloy-coated as required to be compatible with material in contact with them.

E. Insulation material shall be type XHHW, THHN, or THWN rated for 600 V.

F. Jacket material shall be flame resistant, self-extinguishing, heavy-duty, black, which is oil, heat, moisture, weathering, abrasion and chemical resistant.

G. Cables shall consist of individually insulated conductors, bunched and filled to be round in cross section. All fillers and binder tape to be non-hygroscopic and flame retardant. Binder tape shall have a minimum 15 percent overlap.

H. Conductor color-coding shall be in accordance with ICEA S-95-658. White or Green conductors shall not be provided.

I. Individual conductors shall pass the VW-1 vertical wire flame test of UL 44. Completed cables shall meet or exceed the requirements of UL 1277 and pass the vertical tray flame propagation test in accordance with utilizing heat from a 70,000 BTU per hour burner.

J. The cable shall be surface printed or embossed on the overall jacket at regular intervals with, as a minimum, manufacturer’s name, voltage rating, size and number of conductors, insulation and jacket type, temperature rating and sunlight resistance.

2.03 Telecommunications Cable:
A. Provide Category 6 unshielded twisted pair (UTP) cables that meet the criteria of TIA/EIA-568 and IEEE STD-802.3 standards for data and voice premise installations.

B. Cable materials and construction:
   1. 24AWG or larger.
   2. 4 twisted pair.
   3. Unshielded.
   4. Solid conductor.
   5. Plenum rated.
   6. 100 ohm impedance.
   7. Color: Blue for data premise and white for voice premise cables.

C. Data and voice cables shall be bundled, routed, and terminated separately subject to approval by the UT.

D. Maximum cabling run is 90 meters (295 feet) including patch and drop cables in accordance with IEEE STD 802.3.

E. Identify and label cables in accordance with TIA/EIA-606 standard.

2.04 Fiber Optic Cables:
A. Strands: Coordinate with UT for specific application.
B. Material Structure: Silica.
C. Mode: Multimode or Single Mode (for long haul applications).
D. Core/Cladding Diameter: 62.5/125 micron.
E. Operating Temperature: -40°C to +85°C.
F. Maximum Attenuation: 3 dB/km at 850 nm and 1.0 dB/km at 1300 nm.
G. Jacket Material: Flame Retardant PVC (plenum) and high temp plenum fluoropolymer (riser), UL rated (OFNP, OFNR).

2.05 Terminations and Connectors:
A. Provide high conductivity ring or spade lugs as required for copper conductor termination at terminal blocks.
B. Provide RJ-45 connectors for data and RJ-11 connectors for voice UTP cables in accordance with TIA/EIA-568.

C. Provide type ST connectors in accordance with TIA/EIA-568:
   1. Insertion Loss (IL): 0.5dB max.
   2. Return Loss: 45dB typical.
   3. Repeatability of IL: 0.1dB.

2.06 Raceways (Conduit or Cable Tray):

A. Refer to Design and Construction Standard 5.26.05 section 2.03.

B. Provide raceways for instrument and control cable/wiring where subject to mechanical damage and at levels below 10 feet in mechanical, electrical, or service rooms.

C. Provide raceways sized and wire size and type selected in accordance with manufacturer's recommendations and NEC requirements.

D. Provide rigid raceways with supports, reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings and according to code.

E. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Liquid-tight flexible metal raceways shall be used in areas exposed to moisture including chiller and boiler rooms.

2.07 Instrument Tubing:

A. Process instrument tubing shall be hard temper seamless copper conforming to ASTM B-88.

B. Provide 3/8-inch tubing for process input to pressure or flow transmitters, flow indicators, flow or pressure switches, pressure gauges, and analyzer sample lines.

C. Provide Swagelok fittings for tubing.

2.08 Coaxial Cable:

A. Provide coaxial cable as required by the related equipment manufacturer’s rating requirements.

2.09 Identification:

A. Provide type written, self-laminating cable and wire markers using black characters on white background:
1. Cables: Mark at both ends where cable designation is the origination – destination. For example, CHW-FT-0100: CP1-TB2-15/16.s.

2. Wire (conductors): Mark with final destination. For example, TB2-15.

**PART 3: EXECUTION**

3.01 Installation

A. Provide details for typical and special wiring installations on construction documents.

B. Maintain equipment and cable separation between EMI/RFI emitter and EMI/RFI sensitive equipment as shown in the table:

<table>
<thead>
<tr>
<th>EMI/RFI EMITTER OPERATING VOLTAGE</th>
<th>SEPARATION DISTANCE (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 125V</td>
<td>3 meters with no shielding; 1 meter with shielded enclosure.</td>
</tr>
<tr>
<td>Less than or equal to 125V</td>
<td>None</td>
</tr>
</tbody>
</table>

Notes:
1. Avoid separation distances that are equal to 1/4 wavelength of EMI.
2. Maintain separation distances at the back of equipment where 120 VAC or 125 VDC supply and signal lead connections are terminated.

END OF STANDARD
PART 1: GENERAL

1.01 Purpose:

A. The design guidelines contained herein include the requirements for integrated automation facility controls at The University of Texas at Austin. It is the intention of this document to provide a standard for at the University that represents the highest level of quality and consistency possible.

1.02 References:

A. ANSI/HFS 100 - Human Factors Engineering of Visual Display Terminal Workstations

B. IEEE 802 Series - Information and Technology Standards for Local & Metropolitan Area Networks (LAN/MAN).

C. EEE Std-1100 - Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.

D. ISA-5.1 - Instrumentation Symbols and Identification.

E. ISA-5.3 – Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems

F. ISA-5.4 – Instrument Loop Diagrams.

G. NEMA 250 – Enclosures for Electrical Equipment (1000Volts Maximum)


I. TIA/EIA-232 - Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

J. TIA/EIA-485 - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

K. Underwriter’s Laboratories – (specify individual standards per project application).

1.03 Requirements:

A. This section is intended to convey the minimum performance requirements related to integrated automation facility controls of mechanical systems operations. Confirm specific controls requirements and goals with Owner early in the design process.

B. The BAS includes the hardware, firmware and software necessary to obtain the performance requirements by function and system components for operation, reliability, security, packaging, control sequencing, scheduling, loop tuning, interlocks, system integrations, interlocks, commissioning.
C. The BAS includes equipment such as operator workstations, direct digital control (DDC) panels and controllers, relays, terminal equipment, wiring, cabling, circuit breakers, panel boards, power supplies, and transformers.

D. Project review milestones are required as follows:
   1. Kick-off meeting
   2. Submittal reviews
   3. Proposed display screen graphics
   4. I/O point definitions
   5. Alarm Management
   6. Control Sequences and Scheduling
   7. Pre-Installation meeting
   8. Field walk down
   9. Final Commissioning

E. Protect equipment during delivery and storage. Store equipment in environmentally controlled space prior to installation.

F. Warranty:
   1. Period: 12 months after UT acceptance.
   2. Integrate new building BAS extended maintenance with existing service agreements.

PART 2: PRODUCTS

2.01 Manufacturers:

A. Acceptable Manufacturers:
   1. TAC – Andover Continuum Line, with Infinet protocol.
   2. Siemens - Apogee Line, with P1 FLN protocol.
   3. These are the only BAS systems acceptable to the University.

B. Individual buildings shall have either one of the above listed systems; no building is to have a combination of these systems.

C. The central monitoring station shall have independent operator workstations for the monitoring and control of each system.

D. Other existing equipment from Johnson Controls, such as the JC-80 and Metasys control systems shall be phased out using one of the above listed manufacturers.

2.02 Network Architecture:

A. Communicate via the UT campus-wide VPN (FACNET) WAN operating at a minimum of 100 Mbps for interconnecting on servers, workstations, and building controllers.

B. Base the first tier network on a PC industry standard of Ethernet TCP/IP.
C. Network multiple operator workstations, network controllers, system controllers, and application-specific controllers for a complete BAS. The first tier network shall provide communications between operator workstations and first tier DDC (Direct Digital Control) controllers.

D. Existing systems use a primary application server and a backup server which interface to the system processes. The primary server is located remotely from the backup server. The system data is mirrored on the servers and automatically switches from primary to the backup upon loss a server. When system is expanded, due to new building additions, determine the adequacy of the server size and increase server capabilities as necessary to ensure operations reliability and speeds.

E. The existing system also provides system information to outside users via a web server; coordinate with UT IT Department for firewall and security requirements. Modems, wireless devices or other remote type communication devices which circumvent network security shall not be used for access to the BAS.

F. Building communications connections shall be by UT. Coordinate location, and cabling details with UT.

G. Second tier networks shall provide either "Peer-to-Peer," Master- Slave, or Supervised Token Passing communications, operating at the fastest available communication speed, with a minimum of 9600 baud.

H. The BAS shall include appropriate hardware equipment and software to allow two-way data communications between the BAS and 3rd party manufacturers’ control panels. A minimum of 100 third-party controllers shall be supported on a single network.

I. Provide repeaters to detect and repeat signals from one LAN segment to other segments.

J. Provide gateways for integrating third party systems using Modbus, Devicenet, or DH+ protocols. OPC servers can also be used for diverse system integration. The OPC Server shall have the following characteristics and functionality:

1. Run on Microsoft OS Based machines connected via Ethernet to the BAS.
2. Allow generic components to be used and shared with other OPC-compliant clients and systems.
3. Serve as the "translation service" for the various languages used by the diverse systems with which it communicates.
4. Support multiple OPC clients running on both local and remote machines in the network.
5. Control the interaction and communication between workstation applications (on clients) and the BAS by providing standard methods for sharing and exchanging data between the BAS and other systems.
6. Provide interfaces for browsing, reading, and writing accessibility.

K. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients.
2.03 System Software:

A. Provide integrated multi-tasking software package for operator interface use to control and monitor the BAS. The same programming language will be used for controllers, networks, algorithms, alarms, I/O points, calculations, and control sequences.

B. Provide workstation graphics similar to those already used for like in kind system applications at UT Austin main campus.

C. Software programs shall be fully described with annotations in each section such that others may follow and understand the original programmer’s logic and intent of the software code.

D. Provide system application software functions:

1. Graphics:
   a. Add, delete, or change graphics on line.
   b. Library of standard HVAC equipment such as boilers, chillers, air handlers, terminals, fans, pumps, instruments, valves.
   c. Dynamic (animated) and static displays.
   d. Display alphanumeric text and data.
   e. Equipment operating status.
   f. Alarms.

2. Display screens for:
   a. Campus map: campus and remote sites divided into geographic sections.
   b. Building grid: tabular form using 3 letter acronyms for each building, arranged alphabetically on the grid.
   c. Diagnostics: main system diagnostics with links to the buildings.
   d. Building floors: general status information (room temperature & humidity) on overall graphic and enlarged floor plans.
   e. Occupancy schedule.
   f. Alarm summary and history: active and acknowledged alarms in tabular format last in at top of list; alarms stored in history after acknowledged and alarm condition cleared.
   g. Equipment performance: based on systems.
h. Trending and reports: graphical and tabular format of system operations.

i. Control tuning: links to system equipment for loop tuning.

j. O&M Information: links to BAS equipment operations and maintenance manuals, including as-built drawing information.

3. System configuration.

4. Controller PID tuning.
   a. Group all interrelated process points on same graphic screen.
   b. Log tuning data.
   c. Document loop tuning results from bump tests.

5. System database.

6. System historian. Provide historical logs in logical groups for system operations:
   a. Collect data at 15 minute intervals
   b. Average data over 72 hour window
   c. Archive historical data to DVD at 50% server memory capacity.

7. System clock synchronization.

8. System diagnostics.

9. Security:
   a. Password access. Minimum of 5 levels of access related to system operational control, monitoring, and programming functions.
   b. Virus protection. Spam and Adware S/W.

10. Alarm Management:
   a. Classification:
      i. Critical: conditions that require immediate action by the operator for personnel safety, equipment protection, and major equipment alarms.
      ii. Non-critical: those that will not disrupt system operations.
      iii. Application specific: those that are related to research versus office environmental controls.
b. Configurable: Normal or bypassed.

c. Setpoint: adjustable limits.

d. Equipment status.

e. I/O point range validation.

f. Event log date, time, and operator actions.

g. Alarm response audit trail.

h. Email notification.

11. Reports:

a. Energy usage.

b. Equipment runtimes.

c. Equipment status.

d. Alarm summary.

e. Trend logs:

f. Real time and historical data.

g. Up to 8 parameters on same trend.

h. Adjustable time and magnitude scales.
   i. Triggered trends based on preset parameter changes:
      ii. Chilled water delta temperature drop
      iii. Chilled water delta temperature rise

12. Schedules:

a. Start/stops.

b. Time of day.

c. Temperature optimization.

d. Demand Limiting.

e. Day/night setback.

f. Weekly, monthly, holiday by system.

g. Temporary overrides.

2.04 System Performance:

A. Provide controllers that execute PID control loops at a frequency not to exceed 1 second. The process variable scan and updated calculated output rate is at same rate.
B. Custom and standard application execution times must be consistent with or faster than mechanical processes under control.

C. Graphics update rates:
   1. Display Refresh: 20 dynamic points in 5 seconds
   2. Object Command: 2 seconds
   3. Object Scan: 2 seconds
   4. Alarm Response Time: 5 seconds when point goes into alarm
   5. Multiple alarms: 3 seconds of each other

D. Control Loop Stability:
   1. Air Pressure – 0.2” WG
   2. Airflow – 100cfm
   3. Temperature – 1F
   4. Humidity – 5% RH
   5. Fluid Pressure – 1.5 psi
   6. Fluid Flow – 2%

2.05 System Diagnostics/Failure mode:

A. Provide the BAS with system diagnostic programs to include:
   1. Initiation Checks
   2. On-Line Diagnostics
   3. Off-Line Diagnostics

B. Provide diagnostic programs with alarms to alert the operator upon detection of a fault.

C. Provide BAS software to re-initialize system upon fault or power restoration, unless operator intervention is deemed necessary.

D. Provide BAS software so that the system will fail in a predictable manner to ensure integrity and safety of system equipment and operation.

2.06 Operator Interface:

A. Utilize existing operator workstations in the central control room or directed otherwise by UT.

B. Operator workstation based on Dell commercial off-the-shelf personal computer (PC) hardware, AE to specify equipment (hardware and/or software) as needed; workstation components include:
   1. Dual flat panel monitors.
   2. Laser color printer
   3. Dual network interface card
   4. Sound card
   5. Mouse
   6. Keyboard
C. If specified in the Project Documentation, provide a portable operator terminal for command entry, information management, network alarm management, database management, system diagnostics, interrogate and re-program any point in the system from any DDC panel.

2.07 Web Browser:

A. Web browser access is through the UT Austin campus LAN, which is protected by a firewall.

B. Provide a Thin Client web browser function, with intuitive mouse/menu driven interface, to view process data via local or wide area networks.

C. Provide objects such as:
   1. Point record value
   2. Point summary information
   3. Trending Logs
   4. Process Diagrams
   5. Schedules
   6. Reports

D. Provide security and access control through a login page that requires a user login and password.

E. System data monitoring and control function access dependent upon assigned role privileges and area of responsibility.

2.08 Controllers:

A. Configure to maximize the standalone operation of the BAS system for each logical group of equipment if communications are interrupted. Real-time control functions, including scheduling, history collection and alarming, shall be resident in the BAS controllers to facilitate greater fault tolerance and reliability.

B. Network Controller: interfaces applications specific controllers together, to other network segments, and to the system servers/ operator workstations.

   1. Provide microprocessor based controller:
      a. Word size of 16 bits
      b. Scan rate 1 second (maximum)
      c. Memory as needed for its self-function and lower tier controllers.
      d. Real time clock.
      e. Communications:
         i. Open system port.
         ii. Two EIA-232
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DESIGN AND CONSTRUCTION STANDARD

f. Initial configured such that only 80% of the available nodes are used for system installation.

g. Each Network Controller shall store trend and point history data for all analog and digital inputs and outputs.

h. Network Controllers shall be fully user-programmable supervisory controller. The Network Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers. Controllers shall be listed by Underwriters Laboratories (UL).

i. Internal or external transient voltage and surge suppression shall be provided for workstations and controllers.

C. Application Specific Controllers: configured to maximize the standalone operation of the BAS system for each logical group of equipment.

1. Operates as standalone controller for equipment such as:
   a. Boiler
   b. Chiller
   c. Cooling Towers

2. I/O points (Refer to standard I/O points list)
3. Local display
   a. Point data
   b. Audible and visual alarm indication
   c. Password protected

4. Memory sufficient for control programs and historical logging buffer for equipment group.
5. Local override with auto-off-on switches.

2.09 Control Panels:

A. Provide NEMA rated hinged indoor control cabinets/panels, according to location service hazards.

B. Provide panels as wall or floor mounted (on legs or house keeping pad).

C. Provide UT standard CH751 lock cylinder on each panel.

D. Panels for electronic control equipment shall be vendor’s standard color with standard UT panel labels.

2.10 Power Supplies:
A. The BAS shall be powered from an electrical distribution panel that is backed by the facility’s UPS.

B. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure. Unit shall operate between 32°F and 120°F. EMI/RFI shall meet FCC Class B. Line voltage units shall be UL recognized and CSA listed.

1. Internal or external transient voltage and surge suppression shall be provided for workstations and controllers. Surge protection to include:
   a) Dielectric strength of 1000 V minimum
   b) Response time of 10 nanoseconds or less
   c) Transverse mode noise attenuation of 65 dB or greater
   d) Common mode noise attenuation of 150 dB or greater at 40-100

PART 3: EXECUTION

3.01 Factory Acceptance Test (FAT):

   A. The FAT test procedure shall provide step-by-step instructions and data sheets for test personnel to follow and complete while testing the system.

   B. The FAT shall test the system hardware and software including:
       1. Input/Outputs.
       2. Display Screens
       3. Field Controllers and control loop tuning.
       4. I/O Database Verification.
       5. Network Connections and I/O Wiring Terminations.
       6. Data throughput.
       7. System sequence of operations.
       8. System response times.
       10. System interfaces with third party equipment.
       13. Data trending (real time and historical) and reports.

3.02 Site Acceptance Test (SAT):

   A. The site acceptance test shall be field-initiated and observed, not simulated.

   B. The SAT/Commissioning shall test 100% of all field devices through the BAS I/O points and as displayed on the graphic displays.

   C. All test design and commissioning shall be designed and performed using the deliverable “AS BUILT” control drawings, graphics and control programs.
D. Control sequence and operation shall be verified by system reaction to signal from device(s).

E. The SAT procedure shall be based on the FAT test procedure with the exception that the inputs and outputs shall be field initiated and observed, not simulated.

F. The SAT shall test the system hardware and software including:
   1. Input/Outputs.
   2. Display Screens
   3. Field Controllers and control loop tuning.
   4. I/O Database Verification.
   5. Network Connections and I/O Wiring Terminations.
   6. Data throughput.
   7. System sequence of operations.
   8. System response times.
   10. System interfaces with third party equipment.
   11. System interface with the existing WDPF II system.
   14. Data trending (real time and historical) and reports.
   15. Asset management functions.
   16. Simulate addition of field devices, logic program changes, generation of custom graphics and reports.
   17. Verification of “AS BUILT” drawings.

G. Final performance testing shall confirm the following:
   1. Maximum overshoot of 20%.
   2. Achieve stability in 5 minutes or less depending on system control sequences.
   3. Initial response of 20% command within 1 minute.
   4. Anti-hunting/minimum cycling of control loop.

H. A test report shall be submitted upon completion of testing activities.

3.03 Training:

A. Training shall be specific to each Project. The Project Documentation will detail the training required which may include any, all or additional areas of training to those listed below.

B. Controls system training shall be provided to UT Austin staff by controls contractor and controls system manufacturer. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods as determined by UT Austin per project. Instructors shall be factory-trained and experienced in presenting this material. Classroom training shall be accomplished using a network of working controllers representative of installed hardware.

C. Training shall enable students to accomplish the following objectives:
1. Proficiently operate the system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate workstation and peripherals
6. Log on and off system
7. Access graphics, point reports, and logs
8. Adjust and change system set points, time schedules, and holiday schedules
9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
10. Understand system drawings and Operation and Maintenance manual
11. Understand job layout and location of control components
12. Access data from DDC controllers
13. Operate portable operator's terminals
14. Create and change system graphics
15. Create, delete, and modify alarms, including configuring alarm reactions
16. Create, delete, and modify point trend logs (graphs) and multipoint trend graphs
17. Configure and run reports
18. Add, remove, and modify system's physical points
19. Create, modify, and delete application programming
20. Add operator interface stations
21. Add a new controller to system
22. Download firmware and advanced applications programming to a controller
23. Configure and calibrate I/O points
24. Maintain software and prepare backups
25. Interface with job-specific, third-party operator software
26. Add new users and understand password security procedures

D. Presentations of objectives shall be divided into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.
   1. Day-to-day Operators (objectives 1-13)
   2. Advanced Operators (objectives 1-13 and 14-23)
   3. System Managers and Administrators (objectives 1-13 and 24-26)
   4. System Administrator (objectives 1-26).

3.04 Sequence of Operation:

A. Equipment sequence of operations shall be shown within the mechanical drawings or specifications for each system/component, including, air-handling unit, fan, pump, chiller, boiler, air compressor, heat exchanger, terminal heating and cooling unit and any other BAS monitored or controlled device.

B. Two sets of “AS BUILT” documentation shall be delivered to UT.

C. Two sets of “AS BUILT” control programs and points list shall be delivered to UT.
3.05 Typical Points List:

A. Provide points lists for each major piece of mechanical equipment and balance of plant equipment in the construction documents.

B. See Appendix for typical equipment points list.
25 55 00 – PNEUMATIC CONTROL SYSTEMS
DESIGN AND CONSTRUCTION STANDARD

PART 1 - GENERAL
1.01 Purpose:

A. This design guideline contained herein includes the requirements for pneumatic control systems at The University of Texas at Austin. It is the intent to provide the highest level of quality and standardization possible.

B. This design guideline applies only to renovation applications where the existing control system is to remain pneumatic.

1.02 References:

A. Codes and Standards that are Standard at the University:

1. Electrical Standards: Provide electrical components of pneumatic control systems, which have been UL-listed and labeled, and comply with NEMA standards.

2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for pneumatic control systems.


1.03 Requirements:

A. Provide manufacturer’s verification that instruments and control valves supplied are appropriate and acceptable to meet specified performance criteria for the intended application.

B. Provide instruments including pipe, tubing, manual valves, supports, pipe and tube fittings, wire/cable, conduit, tray, terminations, racks, mounting stands, mounting plates, and other accessories as needed to complete a working and operable pneumatic control system.

C. Provide intrinsic safety barriers for instruments and actuators that are installed in hazardous areas as defined by NFPA 70.

D. Provide protection for materials during shipment and storage prior to installation.

E. All pneumatic and electro-pneumatic components including dampers, valves and actuators shall comply with UT Austin standards.

PART 2 – PRODUCTS
2.01 Acceptable Manufacturers:

A. Subject to compliance with requirements, provide pneumatic control systems of one of the following:

1. Honeywell, Inc.

2. Johnson Controls, Inc.

2.02 Materials and Equipment:

A. General:

1. Provide pneumatic control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, sensors, controllers, and other components as
required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by manufacturer, and as required for application indicated.

B. Air Piping:

1. Complete air piping systems adhering to the highest standards of quality and appearance shall be provided for each pneumatic control system.
2. All piping shall be concealed except in mechanical rooms or areas where other piping is exposed. Hard drawn copper tubing shall be used in all exposed areas, and in all concealed areas except as specifically described to the contrary below. Where copper tubing is run exposed, each tube shall be securely fastened at intervals no greater than 42” for 1/4” tubing and 48” for 3/8” tubing. Fasten tubing with metal gang straps, type Johnson controls, F-1000-64 or approved equal. All tubing shall run parallel to the building lines. Only tool-made bends will be acceptable.
3. Fittings for copper tubing shall be hard drawn brass or copper solder joint type except at connections to apparatus, where brass compression or barbed typed fittings shall be used.
4. All pneumatic tubing shall be routed to within a maximum of 18” of each control actuator. At actuators, contractor shall minimize the use of poly tubing and associated fittings. At junctions with main air tubing, contractor shall limit use of poly tubing to a maximum run of 6” and install isolation valves at each connection with the main.
5. All tubing shall be periodically tested for leaks during installation and all tubing shall be blown out to purge installation impurities and moisture before connections to the control instrument. The entire piping system shall be tested by placing it under 30-psig pressures for 24 hours. The pressure drop during this period shall not exceed 2 psig.

C. Pneumatic Actuators:

1. Actuators shall be of cast metal bodies with field serviceable neoprene diaphragm and shall include adjustable springs and stops to permit proper synchronization of dampers. They shall be ample size to develop a torque 50% greater than required by the load imposed on them (15 inch-pounds minimum). Actuators shall be of the long stroke design such that the stroke length is attained without the use of levers, short coupled crank arms or other devices. All actuators shall have an actual and direct stroke length equal to or greater than the diameter of the diaphragm.
2. Provide a minimum of one actuator for each damper and one actuator for each 16 square feet of damper area.
3. Dampers 16 square feet and smaller shall be driven by an externally mounted damper actuator. Dampers larger than 16 square feet shall have each section independently driven by a separate internally mounted damper actuator. Actuators on multi-section dampers shall operate smoothly and in unison.

D. Room Thermostats:
1. Approved thermostats are Johnson T-4002 and Honeywell TP970, direct or reverse acting, to match what exists in the building. These are the only approved models, no substitutions.

2. Thermostats provided shall be full-proportioning type or two-positioning as required and shall control within plus or minus 1 degree F of the temperature setting at the thermostats location, unless otherwise specified.

3. Room thermostats shall have bi-metal element, adjustable setpoint, pneumatic feedback, be two-pipe with calibration gauge test port. Public and general assembly spaces shall have concealed adjustment under locking type covers without thermometers to prevent unauthorized adjustments or damage. Other spaces shall have similar thermostats with occupant adjustability. Finish shall be nickel or approved equal.

4. Thermostats shall be mounted on (stainless steel) cover-plates for 4" x 4" junction boxes. The cover-plates shall be secured by slotted or Phillips screws to plaster rings of depth suitable to the sheetrock thickness. The plaster rings shall be secured to 4" x 2 1/2" electric junction boxes.

E. Sequencing Cumulator:

1. The sequencing cumulator shall provide an output of 2 to 9 psi below the input, field adjustable. The sequencing cumulator is used to skew the pressure to the cold damper, since the hot and cold damper actuators have the same (8 to 13 psi) spring range. Johnson Model No. C-9200-1.

F. Air Gauges:

1. Air gauges of at least 2” in diameter shall be installed for visual indication of supply air, control air, and reset air pressure at all remote bulb thermostats, static pressure controllers, relays, E.P. switches, and comparators.

2. Gauges shall be located at each valve, damper actuator, and all other points throughout the system where visual indication of air pressure is required for operation purposes. All such gauge dials shall be visible from the floor. Gauge bodies shall be of stamped metal, threaded gauge connections and Bourdon tube shall be of brass only. Two types of gauges shall be used: P – pressure gauge; TP – temperature reading pressure gauge.

G. Control Valves:

1. The control valve shall be modulating plug or cage trim type. The valve shall be cast brass with female pipe thread connections. The valve shall be operated by a pneumatic actuator, which has a die cast aluminum body with a field serviceable neoprene diaphragm.

2. Actuator assembly should be removable by loosening a single screw without disturbing the valve assembly. Large flanged valves to be VSI characterized v-ball or Keystone figure 360, with 158 trim with actuator, positioner and gauges.

H. Isolation Valves:
1. Pneumatic tubing isolation valves shall be type Parker XV500P series

I. Solenoid Valves:

1. Solenoid valves shall be 24 VDC, 9 watts maximum or proper voltage for system.

2. Solenoid valves shall be rated for 50 psig when used for 25 psig or less applications, or rated for 150 psig when used for 100 psig or less applications.

3. Coils shall be equipped with transient suppression devices to limit transients to 150 percent of the rated coil voltage.

J. Pressure-Electric (PE) Switches:

1. Brass bellows, operating pressure rated 8-60 psig differential pressure range with maximum overpressure of 180 psig, 1.5 psig switch differential. SPDT snap-acting switch, 6 amp contact rating at 120 volt, 50/60 Hz, UL listed.

2. Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

PART 3 – EXECUTION

3.01 Installation:

A. Provide details for installation instructions to match any special installations as found during area examination and inspections. Otherwise install systems and materials in accordance with the manufacturer’s instructions.

3.02 Testing:

A. Controls equipment to be calibrated and tested by qualified controls contractor, not the mechanical contractor. Controls contractor to have a minimum of 5 years’ experience calibrating this type of equipment.

END OF SECTION
PART 1: GENERAL

1.01 Electrical/Telecommunications Design

A. This section of the design and construction standard outlines general requirements for electrical and telecommunications designs to be performed for the University of Texas at Austin. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section and the ones that follow such that the University may achieve a level of quality and consistency in the design and construction of their facilities.

1.02 Electrical Space Planning Guide

A. The following requirements are to be used by architects for electrical space planning considerations at the conceptual design level. Refinements and modifications will be considered upon evaluation of the specific requirements in the building, but as a minimum, allow space according the following guidelines:

1. Main Service Entrance room shall provide for adequate equipment and maintenance clearance. Provide outside equipment access to this room.
2. Electrical rooms shall be centrally located and “stacked” so that feeder conduits and bus duct are run as straight and short as possible.
3. Doors shall swing out where possible and as required by the National Electrical Code (NEC).
4. Electrical rooms shall not share space with storage, telecommunications, janitor’s sink, and piping.
5. If possible locate electric rooms away from outside walls, elevator shafts, stairwells, HVAC duct chases, trunk runs, and other Utility Avenues so that branch circuits can fan out in all directions.
6. Locate electrical room where it is not susceptible to flood from heavy rains, broken pipes, stopped drains, or fire hose deluge.
7. Provide a separate space in the building for storage of spare lamps.

1.03 Polychlorinated Biphenyl (PCB) Remediation

A. This section provides general guidance concerning the specific preferences of The University for abatement or removal of polychlorinated biphenyl (PCB) within buildings.


C. General Requirements:
1. Bulbs: Fluorescent light bulbs contain mercury. These bulbs must be handled carefully so that they don’t break, packaged in approved boxes furnished by EH&S, and given to EH&S for disposal.

2. Ballasts: Fluorescent lamp ballasts shall be treated as PCB waste unless labeled “no PCBs.” PCB waste is regulated and must be packaged in drums furnished by EH&S, and given to EH&S for disposal.

3. Fixtures: Fixtures and ballasts labeled “no-PCBs” will be disposed of by contractor in accordance with any applicable regulations.

PART 2: PRODUCTS

2.01 Electrical/Telecommunications Design

A. All products used and specified in Division 26 and 27 must be UL approved and must meet all applicable ANSI, NFPA, IEEE, EIA/TIA standards as indicated in the appropriate sections of this design standard.

PART 3: EXECUTION

3.01 Electrical/Telecommunications Design

A. In addition to the specific requirements of the sections of the standard that follow, use the following as baseline programming guidelines.

B. A typical Division 26 design project for the University shall include, but not be limited to the design and specifications for the following items:

1. Electrical and Telecommunications Ductbank Design. Ductbank will be installed from the University specified manholes to the building electrical and telecommunications service entrance.

2. Main Electrical Service Entrance Equipment: Double ended unit substation.


5. Telecommunication Systems Design: Performed by a registered telecommunication designer.

C. Main Electrical Service Entrance Equipment:

1. As a part of the project cost, the Owner will provide and terminate the necessary (15kV rated) cables from the designated manhole to the main service entrance equipment.

2. The main service entrance equipment shall be a double-ended unit substation configured according to the attached one-line diagram.

D. Building Electrical Distribution Design:

1. The low voltage distribution system shall be separately derived 3 phase, 4 wire 277/480 volt system supplying power to all fluorescent and HID lighting, all 480 volt utilization equipment and all
motors over 7 1/2 hp. From the 480 volt distribution system, a separately derived 3 phase, 4 wire 120/208 volt system will be used to supply power to all incandescent lighting and miscellaneous building power and receptacle circuits.

2. Provide at least one circuit for each classroom and do not connect more than one classroom on a circuit.

3. All large electrical equipment, e.g. transformers and main switchgear shall be located at or near ground level in the building near the power service entrance such that it may be removed if necessary without dismantling.

4. There shall be a complete grounding system with ground bars in each electrical room with distribution equipment or transformers and ground wires with each circuit.

E. Coordination Issues

1. It is the responsibility of the engineering team to prepare Reflected Ceiling Plans that accurately locate and coordinate ceiling panels, lighting fixtures, A/C supply and return grilles, sound system speakers, automatic sprinkler heads, fire and smoke detectors, access doors, and any other ceiling located items.

2. The final drawings shall as a minimum be checked for the following:
   a. Physical space above ceiling for duct work, lighting fixtures, piping, etc.
   b. That no piping of any type encroaches on electrical switchgear.
   c. That electric closets are “stacked” so that feeder conduits and bus duct are in as straight a line and as short a route as possible.
   d. That electric closets are not next to elevator shafts or stair wells, vertical HVAC duct chases and horizontal trunk runs or other Utility Avenues, etc., so that branch circuit conduits can “fan out” in all directions. Do not locate on exterior walls.
   e. That electric panels or terminal boards are not in Janitor’s closets or public areas.

F. Basic Drawing Requirements

1. Electrical, Special Systems and Telecommunications Drawings should be drawn on 1/8” = 1’0” scale or larger floor plans. In conjunction with the requirements listed in sections of Division 26 that follow, the Electrical Drawings should include the following information:
   a. The location of all electric utilization, power distribution and special systems equipment.
   b. All branch circuit and feeder wiring including circuit numbers and circuit schedule.
   c. An overall electrical one-line diagram.
   d. Complete riser diagrams for power and special systems.
e. Detailed lighting fixture schedule including the type designation, manufacturer
   product number, type and size of lamps per fixture, and the accessories and
   methods for mounting the type of fixture
f. Detailed panel schedule for each panelboard, switchboard, motor control center,
   etc. Include breaker, fusible switch size or fuse size, frame size, usage of circuit,
   spares, spaces and connected load for each circuit.
g. Site plan where necessary showing electrical and telephone service entry, duct
   bank and manhole locations and details, exterior lighting, circuiting, and details.
h. Grounding plan.

2. 1/4” = 1’0” scale drawings should be provided for the following:
   a. Typical Rooms.
   b. Electrical vaults and main power distribution areas.
   c. Kitchens and other areas with high density of utilization equipment.

3. Separate drawings should be provided for lighting, power, special systems, and
   telecommunications of each floor and roof.

4. Room names and numbers shall appear on all Electrical Floor Plans. Special systems
   floor plans will require door numbers as well.

5. Column lines and designations, plan North, and graphic scale shall appear on all
   sheets as they shall appear on all Architectural Sheets. All drawings shall be dated
   and signed for each Review Submittal.

G. Specification Requirements

1. Electrical and Telecommunications Specifications shall be complete and in the CSI
   Masterspec format. Specifications shall be tailored to the project and not contain
   items that are not a part of the project.

2. Electrical Specifications should not instruct the contractor or installer to size a piece
   of electrical equipment according to the National Electrical Code. All electrical
   designs should be complete and appear as such on the Drawings and Specifications.

3. A clear statement shall be made concerning construction power; where available, and
   at what voltage and phase, who makes and removes the installation, and who pays for
   the energy.

4. Specify non-proprietary equipment. Specify products with proven reliability. Include
   at least three manufacturers for all equipment.

5. Utility Specifications

K. Design Review

1. Schematic design review (3% overall) shall include:
   a. Narrative description of services: electrical, communications, central clock
      control, FCMS, CCTV, etc.
b. Narrative description of electrical distribution, utilization voltages, lighting types, illumination levels.
c. Rudimentary site plan with scale.
d. Basic floor layouts.

2. Preliminary Design Review or DD (15% overall) shall include:
   a. Site plan showing services.
   b. Major electrical routing and equipment on background sheets (floor plans) with scale, North arrow, a column lines.
   c. Typical lighting layouts for several representative areas.
   d. Rudimentary one-line diagram.
   e. Preliminary design presentation.
   f. Special requirements, e.g., grounding, floor duct, plug mold, etc.
   g. Rough draft of specifications.
   h. Preliminary stage is subject to change and must yield to HVAC Utility routing.

3. Interim Design Review (60% overall) shall include:
   a. Switchgear and panels located and drawn to approximate scales.
   b. Lighting layouts including panels.
   c. Several representative lights and receptacles circuited.
   d. Fixture schedule.
   e. Electrical symbols.
   f. Site plan, all services detailed.
   g. Panel schedules near completion.
   h. Conduits larger than 2” size.
   i. Bus duct and cable trays.
   j. Controls.
   k. Details.
   l. One-line-diagram complete, except sizing of protective devices, transformers and feeders for final horsepower selections.
   m. Reflected ceiling plans.
   n. Specifications of all major equipment.

4. Final Design Review (100% overall) shall include:
   a. Design complete except for corrections required from Final Review Comments.
   b. Engineer’s seal on all of the drawings.

END OF STANDARD
PART 1: GENERAL

1.01 Underground Ducts and Manholes
   A. The work included in this section of the construction standards consists of the design requirements for the complete layout and installation of a concrete encased duct system.
   
   B. All excavation shall meet the current requirements of O.S.H.A. and any other governing federal, state or local authority with regard to trench safety. The project engineer shall require a Trench Safety Plan signed and sealed by a registered Professional Engineer of the State of Texas.
   
   C. The Project Service Provider (PSP) shall require provisions for a suitable means of containment and abatement of water run-off contaminated construction materials. These procedures shall meet all local, state, and federal regulations and requirements.
   
   D. Refer to Utilities Specifications.

1.02 Building Wire and Cable
   A. This section includes building wire and cable rated 600V and less.

1.03 Raceways and Boxes
   A. This section of the standard includes minimum design requirements for raceways and boxes used for electrical power, control, and telecommunications wiring.

1.04 Cable Trays
   A. This section of the design standard includes requirements for telecommunications cable tray installation.

1.05 Power System Fault and Coordination Study with Arc Flash Calculations
   A. This section of the design standard includes requirements for a full short circuit, device coordination and arc fault study (The Study) to be performed on the complete electrical system. The Study shall be performed utilizing the current ANSI/IEEE standards.
   
   B. Refer to Utilities Specifications.

1.06 Enclosed Switches
   A. This section includes enclosed switches for use as disconnects in service and distribution systems rated 600 volts and less.

PART 2: PRODUCTS

2.01 Underground Ducts and Manholes
A. Ducts:

1. Must be UL listed.

2. All ducts shall be Schedule 40 Rigid Nonmetallic Conduit or Schedule 40 Rigid Nonmetallic Utility Conduit with integral bell ends.

3. Electrical and Telecommunications ducts shall be 5” diameter standard.

B. Concrete:

1. Electrical designer shall be responsible for coordinating minimum concrete standards with the project civil engineer. The minimum requirements are:
   a. 3/8” minimum aggregate
   b. Slump: 4-1/2” – 5”
   c. Strength: 3000 psi, in accordance to ASTM 039-44
   d. Electrical concrete envelope shall contain red dye at 8 lbs. per cubic yard of concrete.
   e. Install #4 reinforcing steel laterally and #4 stirrups at 4 ft. on center on all four corners through length of duct banks

C. Manholes

1. The manhole shall have grade 60 reinforcement of H20 loading and 4500 psi concrete. Pre-cast terminators shall be provided at each penetration shown on the drawings.

2.02 Building Wire and Cable

A. All conductors shall be soft drawn annealed copper, ninety-eight (98%) conductivity, continuous, from outlet to outlet.

B. Minimum size of wire shall be #12 AWG. (Exception: Control wire may be #18 AWG.)

C. Conductors #8 AWG and larger shall be stranded.

D. Conductors #10 AWG and smaller shall be solid.

E. All wire insulation for 600V conductors shall be type XHHW, THHN, or THWN.

F. Non-metallic sheathed cable is strictly prohibited.
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DESIGN AND CONSTRUCTION STANDARD

2.03 Raceways and Boxes

A. All electrical raceway design shall conform to the minimum requirements of the latest edition of the National Electric Code (NEC).

B. All floor boxes used at the University of Texas in new construction shall be cast in-place. No poke-thrus are allowed in new construction.

C. Building renovations may use UL approved fire rated poke-thrus on approval of The University.

2.04 Cabletrays

A. Cable tray shall be aluminum minimum 12 inches wide ladder bottom supported from both sides sized to support the cabling load.

B. Solid bottom cable tray is permissible in the event that the working clearances as described below cannot be met, or the ceiling space is non-accessible.

2.05 Power System Fault and Coordination Study with Arc Flash Calculations-

A. Acceptable software packages are SKM Powertools.

B. If the Project Service Provider (PSP) makes self-generated calculations a copy of all the calculations shall be included.

C. Submit three (3) copies of the complete short circuit, a copy of the as-build version, device coordination and Arc Fault Study. The study shall include a one-line diagram showing all pertinent equipment data and identify all buses, a list of fault levels at each bus for three-phase bolted faults and ground faults, equipment data including circuit sizes and lengths, equipment interrupting ratings, time-current plots (TCC’s) graphically illustrating protective device settings.

D. Short circuit submittals are required prior to the purchase of any equipment so that the required interrupting current ratings and duties can be substantiated.

E. Final device coordination and Arc Fault Study submittal required prior to energizing equipment. Equipment labels shall be provided for Arc Fault Study.

2.06 Enclosed Switches

A. Use heavy duty enclosed switches only.

PART 3: EXECUTION

3.01 Underground Ducts and Manholes
A. The bank of ducts shall be installed by the built up method. PSP shall require 3” base and intermediate Snap-Loc spacers installed 3” above the bottom of the trench and spaced throughout the ductbank at 6’ on center. The concrete envelope shall be reinforced with #4 rebar along the continuous length of the ducts and #4 stirrups located at 4’ intervals. Ducts and reinforcing shall be anchored into grade prior to concrete placement to prevent duct floating.

B. Grounding: Ductbanks containing power conductors shall have one #4/0 bare copper ground located in the lower portion of the ductbank. The ground conductor shall extend 4 feet into buildings and manholes.

C. PSP shall require factory bends and sweeps of 36” minimum radius and/or combination of 5 degree couplings.

D. Provide 25% spare electrical conduits and 50% spare telecommunications conduits. Minimum size ductbank shall be 6 conduits.

E. Manhole Grounding and Design

1. Grounding System:
   a. Ductbank grounding conductor shall penetrate wall of manhole on all applicable sides and extend 4’ inside the manhole.
   b. A looping grounding system consisting of #4/0 bare copper wire shall completely encircle each manhole and shall be thermo-welded at all connections including the ductbank grounding conductor penetrating the manhole. Use of ground rods is not accepted.
   c. Grounding conductor in ductbank shall be connected to the respective building grounding system, main transformer(s) case, and main transformer(s) X0 neutral bushing.

F. Drawing Requirements:

1. Ductbank detail design shall be coordinated through the civil engineer and civil drawings. As a minimum, the electrical engineer shall provide a site plan depicting the quantity of ducts and the general routing of the ducts through the campus infrastructure and plan profiles indicating the quantity and intended conduit layout in the ductbank. The electrical engineer shall locate new manholes, and existing manholes and ducts where applicable to coordination. New manholes shall be indicated and labeled. The site plan shall indicate existing utilities (other than electrical and telecommunications) and locations and coordinate conflicts.

2. The PSP shall provide ductbank details to depict electrical requirements including grounding and minimum cover.

3. The PSP shall provide ductbank sections indicating conduit layout in the ductbank. A plan and profile drawing shall be required for each layout of ducts.
4. The PSP shall provide manhole details to depict proper grounding practices, and typical ring and cover placement.

5. The PSP shall provide details for building penetrations and terminations for each building affected by the design.

3.02 Building Wire and Cable

A. Welds, splices and joints shall not be permitted under any circumstance.

B. No multi-wire branch circuits permitted on campus.

C. Homeruns shall be clearly indicated on the floor plans.

D. MC cable is acceptable for light fixture within a room. Light fixtures and devices must be wired so that downstream devices are not disabled by removal of any upstream device.

3.03 Raceways and Boxes

A. In addition to the minimum NEC requirements all raceway design shall conform to the following guidelines:

1. Installed conduit shall be Rigid Galvanized Conduit (RGC) or Intermediate Conduit (IMC). Electric Metallic Tubing is permissible only in sizes of 3/4” to 2-1/2”.

2. In exposed exterior areas, use only RGC for conduit less than 2”. For conduit 2” or more use rigid aluminum.

3. In wet or corrosive areas use SCH 40 PVC raceway.

4. Liquid tight flexible conduit installed in sizes 3/4” and larger shall not exceed 3’ in length.

5. Flexible metal conduit is permissible in sizes 3/4” and larger with one exception. Applications with fixture tails may be 3/8”.

6. Surface metal raceway:
   b. Laboratories: painted steel.

7. Liquid tight flexible conduit or EMT shall be used under raised computer floors in the length and size necessary to serve the load. The conduit must originate and terminate in the same room. Do not use rubber cord for this application.

8. All direct buried conduit shall be SCH 40 PVC with a minimum diameter of 1” and with rigid galvanized elbows at all surface and wall penetrations.
9. All floor boxes shall be shown on floor plans and clearly denoted as such by symbology.

10. Drawing shall clearly indicate electrical and telecommunications conduit, with sizes, serving the floor box.

B. Conduit shall not be mounted in or on the floor. All drops shall be made from ceiling.

C. All electrical box design shall conform to the minimum requirements of the latest edition of the NEC and be approved for area conditions.

D. Telecommunications Requirements

1. All telecommunications outlet locations shall have a 4” x minimum 2 1/8” deep recessed box with a single gang or double gang device ring with a 1-inch conduit extended to the accessible ceiling space. Follow the material standards for various locations as indicated above in the electrical design requirements.

2. All telecommunications device locations shall be indicated on special systems plans and telecommunications floor plans. It is the responsibility of the electrical designer to coordinate locations with telecommunications consultant.

3.04 Cabletrays

A. Location: Cable tray must be designed to route through the corridors of the building. Designer shall coordinate ceiling elevation requirements through architect and other trades. Cable tray shall be run above water piping. Designer shall provide a 12” vertical working clearance above the cable tray with no continuous obstructions. In addition, a 12” space must be provided on either side for working access.

B. PSP is responsible for coordinating the installation of the cable tray with the Telecommunications Designer. Drawings should clearly indicate that electrical contractor is responsible for cable tray installations.

C. PSP shall show all routing of cable tray on the special systems floor plans and coordinated with the telecommunications floor plans. Floor plans shall indicate firewall penetrations.

D. Firestopping: Penetrations in fire rated walls shall be made to the size of the cable tray and filled with fire pillows.

E. Grounding: All cable tray shall be grounded per the latest requirements of the EIA/TIA standards.

F. Attachments: No medium voltage boxes or conduit shall be physically attached to the cable tray.

G. Indicate mounting height and transition locations on the floor plans.
H. Changes in horizontal and vertical directions shall be made with manufactured cable tray offsets.

I. PSP shall coordinate violations of working space with The University prior to final design of cable tray.

3.05 Power System Fault and Coordination Study with Arc Flash Calculations

A. The study shall be prepared and certified with the registration seal and signature of a Texas Registered Professional Engineer. The Engineer shall be in private practice and should not employed by the manufacturer of the electrical equipment in order to provide a non-biased third party analysis. The Engineer shall be qualified by experience in the preparation of studies having similar requirements and magnitude.

B. The initial copy of the study shall be submitted prior to the purchase of any equipment so that the required interrupting current ratings and duties can be substantiated. The Electrical Engineer shall indicate equipment ratings on the electrical drawings that are found in the recommendations of the study.

C. The Short Circuit Analysis shall terminate at each branch bus at the lowest utilization voltage secondary bus where the symmetrical short circuit RMS amperes are less than 10,000 amperes (10,000 amperes total source plus all motor contribution). It is the intent of these standards to determine all locations in the entire electrical system where the symmetrical short circuit amperes meets or exceeds 10,000 amperes at either 208 or 480 volts. The short circuit analysis shall compare interrupting ratings of all electrical protective devices connected to each bus with that of the available fault current at the load terminals of each protective device.

D. The Fault and Device Coordination Study shall include all of the primary protective device time current plots (TCC’s) including the last source side protective device of the electrical service equipment. The primary coordination plots shall be at the ampere scale of the primary voltage and shall include all transformer primary protective devices. The coordination plots shall terminate with each transformer secondary main fuse or breaker and the largest branch fuse or breaker immediately following the secondary main protective device. Where a single secondary main protective device is not installed, the plots shall terminate with the next load side protective device following the first secondary protective device. These secondary breakers or fuses shall be plotted on a secondary voltage ampere scale, and shall include the transformer primary protective device plotted at the same ampere scale as seen at the secondary voltage. The protective device study shall include a separate analysis for phase and ground protection.

E. The Electrical Contractor shall furnish the Engineer all of the as-built wire sizes, insulation types, conduit types, and circuit length for use and verification in the study.

F. The as-built version of this study shall be submitted to The Owner for approval a minimum of 30 days prior to final inspection of the electrical system.
G. Primary loop distribution power shall come from a main 12 kV feeder breaker located in The University of Texas Power Plant. Existing data on settings, CT's, feeder sizes and types, etc., shall be obtained from the Owner.

H. Short Circuit Analysis
   The Short Circuit Analysis shall include the following:
   
   1. A schematic one-line drawing of the entire electrical system. Each motor 10 Hp and larger shall be shown and identified. Each bus shall be assigned an identification number.

   2. Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on a bolted three-phase and phase-ground faults.

   3. At each bus the following shall be calculated:
      
      a. Symmetrical RMS short circuit amperes, calculated using total source and motor contribution reactance and resistance values.
      b. Asymmetrical average three-phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.
      c. Reactance (X) and resistance (R) in OHMS at the voltage of the device being examined, including both Owner's Power Plant source and all motor contributions.

   4. Cable sections shall indicate voltage, wire, size, cable length, reactance and resistance of the section in OHMS, and total X & R to the source.

   5. Transformer sections shall indicate transformer KVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total X & R value in OHMS at the secondary voltage to source, including Owner's Power Plant source impedance plus any primary motor contribution.

   6. Busway and miscellaneous devices shall include all parameters, including operating voltage, section X & R values in OHMS, and total X & R values in OHMS to the source, based on source impedance plus any motor contribution.

   7. Bus summary sheets shall be provided giving consecutive bus numbers, description, voltage, X & R values in OHMS including Owner's Power Plant plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ratio, and asymmetrical factor.

   8. Motor summary sheets shall provide motor description and all pertinent motor data including subtransient reactance for each motor 10 Hp and larger.

I. Protective Device Coordination Study
   The Protective Device Coordination Study shall include the following:
1. Time-current coordination plots (TCC’s) shall be made on 8.5”x11” log-log sheets and shall graphically indicate the coordination proposed for all of the systems. The plots shall include complete titles, and a legend.

2. The Owner's Power Plant relays, fuses, or protective devices shall be plotted with all load protective devices at the same voltage. Owner’s power plant relays are not subject to change, therefore building system protection and coordination must be “under” power plant settings.

3. The transformer’s primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the primary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.

4. Low voltage circuit breakers shall have instantaneous, short delay, and longtime pickup ampere values indicated as applicable to the specific circuit breaker. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.

5. The coordination plots shall include significant motor starting characteristics and large motor protective devices for motors over 50 Hp.

6. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used.

7. A summary tabulation shall be included in the study listing all adjustable protective devices with all recommended settings and each adjustable band included in each device.

8. High voltage relays shall have coil taps, time-dial settings and pick-up settings identified. Current transformer ratios shall be stated. Relays shall be separated by a time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.

9. Similar type plots shall be made for all ground fault conditions and shall indicate any time delay or zone blocking.

10. Ground fault coordination must be coordinated with NEC requirements for service entrance equipment.

J. Arc Flash Study
The Arc Flash Study shall be in accordance with NFPA 70E and IEEE 1584 and include the following:

1. Study shall be based on installed equipment and performed before initial energizing of equipment.

2. Study shall determine incident energy level, minimum approach distance, restricted approach boundary and required level of Personal Protective Equipment (PPE) required for each case as required by Codes and Standards.

3. Engineer shall provide contractor with Arc Flash labels to be placed on equipment. See example label below (Appendices) which shall include:
   a. Equipment Designation
   b. Room Number
   c. Nominal voltage
   d. Flash Protection Boundary
   e. Hazard Risk Category
   f. Incident Energy
   g. Working distance
   h. Date of study
   i. PPE required

4. A summary report shall be provided to owner for approval prior to printing Arc Flash labels.

5. Each location where the hazard risk level is > 2 shall be evaluated to determine the most effective way to reduce the arc flash hazard. Submit to Owner for evaluation.

6. A waterproof as-built single line with incident energy levels shall be posted at each room with a substation, switchboard, or distribution panel.

END OF STANDARD
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DESIGN AND CONSTRUCTION STANDARD

PART 1: GENERAL

1.01 Transformer

A. This section includes liquid filled, pad mounted distribution transformers with primary voltage of 12kV or 4.16kV (The University will determine primary voltage), with a kVA rating as required per project. This section does not include pole type distribution transformers mounted in an enclosure on a pad. The Professional Service Provider (PSP) shall coordinate the requirements of this section with the requirements of the related sections of this standard.

1.02 Metal Clad Switchgear

A. This section of the design standard includes basic requirements for the design of the metal clad switchgear used at the building service entrances. All breakers designed and specified shall use vacuum interrupting technology.

1.03 Service Entrance Equipment

A. This section of the design standard includes requirements for the service entrance equipment for facilities at the University of Texas at Austin.

PART 2: PRODUCTS

2.01 Transformer

A. General: Each transformer shall consist of an incoming high voltage termination section, transformer, and outgoing busway interconnection chamber. The transformers shall be new copper wound and designed with 55 degree Celsius (131 degree Fahrenheit) rating. Each section of the transformer shall have the following ratings:

1. kVA (as required)
2. Impedance: 5.75% or ANSI standard
3. H. Voltage: 12 kV Delta /4.16 kV delta
4. H. V. BIL: 95 kV /60kV
5. H.V. Taps: (2) 2 ½% FCAN and FCBN
6. L. Voltage: 480Y/277 grounded wye
7. L.V. BIL: 30 kV

B. Dielectric: Use FM approve, Envirotemp (FR3), BioTemp or owner approved equivalent with any other required accessories. PSP shall require containment to meet NFPA 70HB90 Section 450-23 without being located in a vault.

C. Protection: The 15 kV transformers shall be protected by phase-overcurrent relays with residually connected ground fault relays controlling a vacuum circuit breaker. A pressure relief device shall be used and the tank shall be rated for 12- rated for 12-psi positive pressure and 5 psi negative pressure.
D. Outgoing Section: The outgoing section shall include all of the required bussing, bracing, and insulating materials required for the maximum fault current available at the secondary bushings of the transformer with an infinite source. The flexible copper connectors between the transformer secondary bushing and the fixed bus shall be provided. The bus bar extension or modification pieces that make up to the busway shall be electrolytically plated tin or silver. Each bus bar shall be insulated over its entire length with Class B (130 degree Celsius 268 Fahrenheit) rated insulating material. The temperature rise at any point in the busway shall not exceed 55 degrees C (131 degree Fahrenheit) rise above the ambient temperature when operating at rated load current.

E. Incoming Section: Terminate incoming cable with heat shrink technology.

F. Installation: Each transformer is to be placed on a housekeeping pad of suitable height to allow for the proper alignment of the 600 VAC busway connection to the 600 VAC Metal-Enclosed Switchgear.

G. Safety Design Issues
   1. Provide signs stating “DANGER HIGH VOLTAGE” at any location where contact with live 15 KV parts is possible. Signs shall be located at the incoming air termination chambers.
   2. Provide signs stating “DANGER 600 VOLTS” at any location where contact with live 600V parts is possible. Signs shall be located at the outgoing air termination chambers.
   3. The signs shall use at least 1 ½” red lettering on a 3” white background.

2.02 Metal Clad Switchgear

A. Design the switchgear in accordance with the latest referenced specifications including NEMA, ANSI, and IEEE standards applicable to switchgear.

B. All switchgear parts shall be new and free from defects in material and workmanship.

C. The switchgear shall be rated 15,000 volts, metal clad, and shall operate on a 12,000-volt (4.16 kV if directed by The University) nominal, three phase, solidly grounded wye, 60 Hz system. The switchgear shall utilize vacuum breaker technology with a line-up including (2) incoming breakers used as load interrupter switches and (2) breakers used as transformer feeder circuits.

D. Enclosure: The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted together to form a rigid metal-clad lineup. Each vertical section shall have the capability of stacking breakers two high and auxiliaries four high. Individual sections shall be completely insulated from top to bottom.
E. Main Bus: The main bus shall extend the entire length of the line-up and shall be rated not less than 1200 amp at 15 kV. The bus shall consist of rigidly supported silver-plated copper bars, braced to withstand not less than 50 kA symmetrical interrupting duty. The bus bars shall be of suitable design and cross sectional area to satisfactorily carry the rated current without exceeding the temperature rise as specified in the IEEE and NEMA standards.

F. Ground Bus: The ground bus shall be of high conductivity copper with a continuous rating of at least 600 amps and shall extend the entire length of the switchgear.

G. Circuit Breakers:

1. All circuit breakers shall be vacuum type and have the following ratings:
   a. Interrupting Rating: 50 kA
   b. Nominal Voltage: 12 kV (15 kV class)
   c. Continuous Current: 1200A or as required by design
   d. Rated interrupting time: 5 cycles
   e. Impulse Level: 95 kV
   f. Close Voltage: 230 VAC
   g. Trip Voltage: AC powered capacitor trip

2. The vacuum breakers used as load interrupter switches shall operate on an open loop radial feed system. These breakers shall be used for switching purposes only and shall not require protective type sensing and circuitry.

H. Protective Relays for Transformer Feeder Breakers:

1. The transformer feeder breaker protective relays shall incorporate three phase (50/51) plus neutral protection (51N), and be powered from the breakers’ 120 VAC source.

2. The protective relays shall be solid state, microprocessor-based, except for electromechanical relays for the tripping contacts.

I. Metering:

1. Metering shall be required on the main breaker for the building service transformers on the high voltage side. The design shall adhere to the following:

2. Metering circuits shall be designed such that they may be tested and calibrated without applying test currents and voltages to any other devices. Position KWH meters such that the display registers are eye-level. Must be Square D Ion 8600.

J. Remote Circuit Breaker Control Switches
1. Provide a NEMA 12 hinged door enclosure, at one end of the switchgear, determined according to a safe egress route, containing wired, redundant, circuit breaker control switches, and comprised of the following:

   a. 4 ea. - Circuit breaker control switches. Westinghouse type W2, or equal.  
   b. 4 ea. - Red "breaker on" light. Data Display Products, or equal.  
   c. 4 ea.- Green "breaker off" light. Data Display Products, or equal.  
   d. Necessary wiring, conduit, etc. to interconnect and provide remote operational circuit breaker control switching, redundant to the standard breaker control switches.

2.03 Service Entrance Equipment

A. Unit Substation:

1. The double-ended unit substation shall include two transformers as required by this section each capable of carrying the entire load. Accessories shall include a de-energized tap changer externally operable with a padlockable handle, combination drain and filter valve with sampling device, manual gas pressure test connection, filling plug and filter press connection in cover, top liquid thermometer, magnetic liquid level gauge, pressure vacuum gauge, removable handhole in cover, and provisions for lifting and jacking.

B. The circuit breakers protecting each transformer shall be as required by this section.

PART 3: EXECUTION

3.01 Transformer

A. Show transformer on one-line diagram with kVA rating, primary and secondary voltage ratings and % impedance.

B. The PSP shall detail the designed location of the transformer(s) on enlarged room detail floor plans drawn to scale.

3.02 Metal Clad Switchgear

A. PSP shall provide single-line diagram showing switchgear with draw-out type breakers.

B. Floor plans details shall be provided with electric equipment room layouts including switchgear and other substation components drawn to scale.

C. Switchgear shall be placed on a 4” housekeeping pad.

D. Single line diagram shall clearly indicate dividing lines of points of acquisition and installation responsibility. The University typically provides the 12 kV cable. This should be clearly shown on the single line diagram.

END OF STANDARD
PART 1: GENERAL

1.01  Wiring Devices

A. This section of the standard includes design requirements for wiring connections, including receptacles and switches to equipment specified in other sections.

1.02  Dry Type Transformers

A. This section includes enclosed dry type transformers for lighting and power loads, with primaries and secondaries rated 600 volts and less.

1.03  LV Power Factor Capacitors

A. This section includes unit capacitors for power factor correction.

B. Reference Utility Specifications.

1.04  Disconnect Switches

A. This section includes enclosed switches for use as disconnects in service and distribution systems rated 600 volts and less.

1.05  Metal Enclosed Distribution Switchgear

A. This section includes metal enclosed switchgear for application at 600 volts and less.

B. Reference Utility Specifications.

1.06  Panelboards

A. This section includes enclosed fusible switch and circuit breaker panelboards for feeders, and circuit breaker type lighting and appliance branch circuit panelboards.

1.07  Busway

A. This section includes feeder and plug-in busway in ratings 150 amperes to 5000 amperes, 600 volts and less.

1.08  Reference Standard

A. Reference standard 6.26.05 Common Work Results for Electrical for related information on underground ducts and manholes, building wire and cable, raceways and boxes, cabletrays, full short circuit device, coordination and arc fault study, and enclosed switches.

PART 2: PRODUCTS
2.01 Wiring Devices

A. Electrical Requirements

B. All electrical switches and outlets used shall be equal to Hubbell heavy duty, specification grade or equivalent quality.

C. Minimum 20 ampere rated switches shall be used for lighting and power loads. In cases where wall dimmers are used, the dimmer shall be solid-state design with flicker noise control. Minimum accepted manufacturer and quality – Lutron Nova T Series.

D. Device faceplates shall be smooth finish hard plastic. Project Service Provide (PSP) shall coordinate color requirements with building architect. Use of vinyl faceplates is strictly prohibited. Galvanized face plates shall be used for all surface mounted devices.

For Occupancy sensors and other lighting design control strategies, refer to Standard 5.26.50.

2.02 Dry Type Transformers

A. Up to 5 kVA: (1ph and 3ph) shall be totally enclosed, self-cooled dry-type with a 150° C insulation system that will not exceed a 80° C rise at a maximum ambient temperature of 40 degrees C.

B. 5 kVA to 25 kVA: (1ph and 3ph) shall be totally enclosed, solid fill, self-cooled with a 180° C insulation system that will not exceed a 110° C rise at maximum ambient temperature of 40 degrees.

C. 30 kVA and above: shall be open, self-cooled dry-type, designed for free convection of air through the windings with a 220° C insulation system that will not exceed a 150° C rise at maximum ambient temperature of 40 °C.

D. Taps in the high voltage winding shall be four each 2-1/2% FCBN for the following ratings: 30 KVA and above, three phase; 5 KVA through 25 KVA, single phase. Taps shall be two each 5% FCBN for all other units except that units rated below 1.0 KVA do not require taps. Additional or smaller taps may be supplied (10% total BN required) if it is the manufacturer’s standard.

E. Transformers used to supply 120 volt lighting or other circuits from 277 volt lighting circuits shall have a Bussmann type HPC fuse holder mounted in the terminal connection compartment, connected to the primary, with a properly rated Bussmann type KTK fuse, removable from outside the connection compartment.

F. Transformer windings can be copper or aluminum.

2.03 LV Power Factor Capacitors
A. The capacitor unit shall be indoor, metal enclosed, and factory assembled, prewired tested and ready for installation.

B. Capacitor unit shall be sized such that the building will operate at no worse than 95% power factor.

C. Capacitor bank shall be rated for a life expectancy of at least 20 years. The enclosure shall be freestanding type NEMA 12. The assembly shall be accessible from the front with a continuously hinged door with a three point locking handle mechanism.

D. All capacitor cells shall be three phase industrial grade, metal encased, utilizing threaded type terminals installed with insulating plastic terminal plate. Only three phase units shall be furnished. Single phase units that have been interconnected shall not be allowed. The capacitors shall be specifically designed for power factor correction and continuous duty.

E. The following control type items shall be included with each assembly:
   1. A microprocessor based field programmable automatic power factor controller shall be provided and designed with the following features:
      a. Digital LED readout or meter indication of actual power factor and power factor setpoint. The setpoint shall be continually adjustable to settings that are leading or lagging from 0.7 inductive to 0.7 capacitive.
      b. Capacitor step display on number of steps activated and the number available.
      c. Automatic or manual mode of operation.
   2. Instrument transformers shall be provided for the necessary inputs into the automatic controller. Control and potential transformers shall be appropriately fused on both sides of the primary and secondary.
   3. Control power transformers shall be provided, if required, for the contractors and associated equipment.

2.04 Disconnect Switches

A. Use heavy duty type non-fused, enclosed switches only.

2.05 Metal Enclosed Distribution Switchgear

A. Switchgear shall be metal enclosed construction, front and rear access, NEMA 1 dripproof, ANSI C37/UL1558, rated 600V and shall operate on a 480/277 or 208/120 volt, three-phase, solidly grounded wye, 60 Hz system. The switchboard shall be designed in accordance with the latest NEMA, ANSI, and IEEE standards applicable to this equipment. These standards shall be referenced in the project specifications.

B. Use only ANSI C37.15/UL1066, drawout mounted, power circuit breakers in the switchgear.
C. Metering:
   1. Coordinate location of metering requirements with The University. If metering at the
distribution switchboard is required use the Square D Ion 8600.
   2. Submetering shall be Square D PM820.

D. Bussing
   1. The bus shall be insulated copper with a current density of 1000A/ in². The insulation
shall be class B (130 degree C) rated material. Bus connections (including the tie bus)
shall be accessible from the rear of the switchboard. All bussing shall be braced for
the maximum available fault current.
   2. Neutral bars shall be full capacity rated.
   3. Provide a ground bus through the full length of each section of the switchboard.
   4. Provide a disconnecting means for the neutral either in the form of a link, or similar
conducting piece, designed to make connection between two suitable terminals or
consisting of a terminal plate or stud provided with a suitable wire connection.
Simple removal of bolts from a single bus bar is not acceptable.

E. Professional Service Provider (PSP) shall require the manufacturer to provide a mimic
bus. Show bussing, connections and devices in single line form using black laminated
plastic strips securely attached on the front panels of the switchboard.

F. Main and Tie section devices shall be individually mounted and compartmented.

G. Distribution section devices shall be individually mounted and compartmented.

H. Auxiliary section devices shall be individually mounted and compartmented.

I. Provide switchboard on 4” housekeeping pad with suitable angle iron embedded in
concrete to allow for proper alignment and anchoring as recommended by the
manufacturer.

J. Future provisions: Switchboard shall be designed with future spaces (15% minimum)
equipped with breakers and such that the future additions may be readily made in the
field.

K. The power circuit breakers shall be equipped with a solid state tripping system consisting
of individual phase monitoring current sensors, a solid state processing device, and a flux
transfer shunt trip. The following protective modes or the equivalents shall be provided as
a part of the solid state tripping:

   1. All breakers shall have long-time pick-up of at least to 1.25 times sensor rating and a
   long time delay of at least 4 to 36 seconds at 6 times sensor rating.
   2. All breakers shall have short time pick-up of at least 4 to 12 times sensor rating and a
   short delay time of at least to 0.05 seconds at 2.5 times short delay pick-up.
   3. Only the feeder breakers shall have instantaneous pick-up (At least 4 to 12 times
   sensor rating). Instantaneous operation is not required on the Mains or Tie breakers.
   If provided instantaneous element must be capable of being disabled.
4. Ground fault protection is required and shall include zone interlocking between feeder circuits and the appropriate main breaker.

L. A redundant and remote set of circuit breaker control switches, for the mains and tie circuit breakers, consisting of the following shall be provided:

1. 1 – NEMA 12 hinged door enclosure, at one end of the switchgear, determined according to a safe egress route, containing wired, redundant, circuit breaker control switches, and comprised of the following:
   a. 3 ea. - Circuit breaker control switches. Westinghouse type W2, or equal;
   b. 3 ea. - Red "breaker on" light. Data Display Products, or equal;
   c. 3 ea.- Green "breaker off" light. Data Display Products, or equal;
   d. Necessary wiring, conduit, etc. to interconnect and provide remote operational circuit breaker control switching.

2.06 Panelboards

A. Panelboard bus shall be 98% conductivity copper. Bus shall be installed completely throughout panel to permit addition of new bolt-on breakers in available space in future without modifying bus.

B. All panelboards shall have door locks. The front cover shall be a door in door arrangement with the inner door hinged to allow breaker handle access.

2.07 Busway

A. Provide copper busway only. B. Service entrance busway to be furnished with switchgear and include 240 volt rated space heaters to operate at 120 volts.

PART 3: EXECUTION

3.01 Wiring Devices

A. Modular Furniture Spine (no telecommunications outlets) shall not be connected to a general purpose receptacle and must be connected by a furniture whip.

B. A typical single person office space should contain a minimum of two duplex receptacles and two communications outlets as shown in the diagram below. Locate the power and data outlets according to the typical office detail 6.26.20-1.

3.02 Wiring Devices

A. A typical open office cubicle shall contain a minimum of two duplex receptacles and one communications outlet per workstation. Locate the power and data outlets according to the typical office detail 6.26.20-2.
5.26.20 LV ELECTRICAL TRANSMISSION
DESIGN AND CONSTRUCTION STANDARD

B. Locate power and communications outlets in interior walls shall be approved on a project specific basis. Do not locate any outlets on exterior walls under windows or on the exterior of the building.

C. Mounting heights for devices shall be as follows:

1. Wall switches and dimmers -- 48” Aff.
2. Receptacles -- 18” Aff.
3. Heights are to center of outlet boxes


3.03 Dry Type Transformers

A. Larger transformers for facilities shall be designed for location on the ground floor if possible. The PSP is responsible for coordinating maximum transformer weights and anticipated floor loading with the project structural engineer.

B. Transformers installed in electrical rooms shall be designed and sized in coordination with architect and door dimensions. All transformers sized above 225 kVA shall require double doors or doors in excess of standard 36” width.

C. Transformers 15 kVA and above are to be floor mounted. Up to 15 kVA may be wall or trapeze mounted if appropriate for the room layout.

D. PSP shall provide detail layouts of electrical rooms indicating transformer locations drawn to scale with special mounting instructions as appropriate.

E. All transformers are to be given an alphanumeric label that will relate the transformer on the room detail to the transformer on the single line diagram.
F. The single line diagram shall indicate the alphanumeric identifier, the transformer size (kVA), and the primary and secondary voltages.

G. Transformers for Non-Linear Loads (K-rated) shall be used at the PSP’s discretion.

3.04 LV Power Factor Capacitors

A. The PSP shall show on the single line diagram the planned locations for installing power factor correction capacitor banks.

B. The drawings shall also indicate location of the capacitor banks in a detail of the electrical room layout.

C. The capacitor assembly shall be installed a minimum of 200 feet measured along the electrical route from the nearest SCR drive or as indicated in the VFD manufacturer’s Harmonic Analysis Study.

3.05 Disconnect Switches

A. The top of the handle shall be no more than 6’6” above finished floor.

3.06 Metal Enclosed Distribution Switchgear

A. PSP shall show equipment room layout, drawn to scale, indicating location of equipment and busway routing for interconnection.

B. PSP shall label the switchboard consistently on the single-line diagram and the room layout.

C. Single-line diagram shall indicate board size and required short circuit rating.

D. PSP shall furnish a detailed specification indicating detailed control wiring, meter requirements and special construction requirements not outlined in the design standard.

3.07 Panelboards

A. Branch circuit panelboards shall not serve loads on more than one level of a building.

B. Molded case circuit breakers shall be bolt-on type only.
C. Do not mount panelboards in hallways or other public spaces. Where an obsolete panel is being replaced in an existing public space, the new panel shall be flush mounted.

D. Provide a separate panelboard for labs or other high density electrical utilization equipment spaces where the power requirements exceed 12 poles, and locate the panelboard near the entrance to and within the space. Provide door locks on all panelboards.

E. Lighting panelboards shall serve only lighting loads and should contain 15% spare capacity in both load and circuit breaker count.

F. Receptacle panelboards, power distribution panelboards, main switchboards and motor control centers should contain 25% minimum spare capacity in both load and circuit breaker count.

G. Panelboards should be designed in the electrical room detail layout such that feeder piping is minimized and installed efficiently. Provide a minimum of two 1” empty conduits from each flush mounted panel to an accessible point above the ceiling.

H. Panelboards shown on single line diagram shall indicate required short circuit amps interrupting capacity (AIC) rating. (May be shown in panel schedules if single-line diagram not appropriate.)

I. Provide panel locations drawn to scale in electric room detail plans.

J. Panelboards shall be labeled with a descriptor indicating location, reference voltage level, and primary loads served.

K. Panel schedules shall be provided indicating panel size, AIC rating, whether main circuit breaker or main lug only style, main breaker size. Panel schedules shall indicate load information in kVA per phase.

L. Distribution panelboards (400A & up) shall have a minimum of 10” of gutter space on both sides.

M. Label utilization equipment with circuit number.

3.08 Busway
A. Clearly indicate bus duct ratings and locations on drawings

<table>
<thead>
<tr>
<th>Room Use</th>
<th>Type of Fixture</th>
<th>Lamps</th>
<th>Fixture Efficiency</th>
<th>Recommended average light levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom, library, office</td>
<td>Lensed or louvered fluorescent</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>45 to 55 foot candles at work surface</td>
</tr>
<tr>
<td>Kitchen, machine shop, laboratory</td>
<td>Lensed or wrap around fixtures</td>
<td>2 to 3 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>50 to 65 foot candles at work surface</td>
</tr>
<tr>
<td>Conference room</td>
<td>Lensed or louvered fluorescent</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>35 to 45 foot candles at work surface</td>
</tr>
<tr>
<td>Lobby, lounge, reception, copy room, exhibit hall, dining, food court, locker, study and common area</td>
<td>Lensed or louvered fluorescent</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>20 to 35 foot candles at 30”AFF</td>
</tr>
<tr>
<td>Restroom</td>
<td>Lensed fluorescent</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>20 to 25 foot candles at 30”AFF</td>
</tr>
<tr>
<td>Corridor with exhibit space</td>
<td>Lensed or louvered fluorescent</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>30 to 40 foot candles at floor level</td>
</tr>
<tr>
<td>Stairway, corridor</td>
<td>Commensurate with architectural finish of space</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>15 to 25 foot candles at floor level</td>
</tr>
<tr>
<td>Storage, mech/elec room</td>
<td>Industrial fluorescent</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>80% or greater</td>
<td>20 to 30 foot candles at 30”AFF</td>
</tr>
<tr>
<td>Computer room</td>
<td>18 cell 3” parabolic i.e. Lithonia 2PM3N series</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>65% or greater</td>
<td></td>
</tr>
<tr>
<td>Exhibit</td>
<td>LED or fluorescent wall wash or track</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
<tr>
<td>Sidewalk</td>
<td>Pole-mount with cut off</td>
<td>–LED or pulse start MH</td>
<td></td>
<td>1 to 2 foot candles at ground level</td>
</tr>
<tr>
<td>Parking</td>
<td>Pole-mount with cut off</td>
<td>–LED or pulse start MH</td>
<td></td>
<td>8 to 10 foot candles at ground level</td>
</tr>
<tr>
<td>UT shuttle stops</td>
<td>Varies</td>
<td>Induction or pulse start MH</td>
<td></td>
<td>10 to 20 foot candles at ground level</td>
</tr>
<tr>
<td>High bay areas</td>
<td>High bay fluorescent</td>
<td>Varies-T8 , 28 watt, 4100K</td>
<td>80% or greater</td>
<td>Varies based on function of space</td>
</tr>
</tbody>
</table>

END OF STANDARD
PART 1: GENERAL

1.01 Overview

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

PART 2: PRODUCTS

2.01 General Requirements

A. Variable torque, variable voltage/frequency type for centrifugal fan and pump applications and suitable for use with both standard and high efficiency 3-phase, squirrel cage, induction motors.

B. Solid state with Pulse Width Modulation (PWM) output waveform. Six step and current source are not acceptable. Full wave rectifier (to prevent input line notching), AC line reactor, fuses, capacitors, and insulated bipolar transistors (IBGT’s) as the output-switching device (SCR’s, GTO’s and Darlington transistors are not acceptable). All standard and optional features included within the VFD enclosure. Approved by the equipment manufacturer for the particular product(s) and application(s) involved.

C. Converter and an inverter section. Converter section shall convert fixed frequency and voltage AC utility power to a DC voltage. VFD shall also include three phase input fuses. The inverter section of the VFD shall invert the DC voltage into a quality output wave form, adjustable voltage and frequency output for stepless motor speed control.

D. Tested to ANSI/UL standard 508. Complete system listed by a nationally recognized testing agency such as UL, ETH CUC or CSA.

E. Power line noise limited to a voltage distortion factor and line notch depth as defined in IEEE 519-1992. Prior to installation, the VFD manufacturer shall estimate total harmonic distortion (THD) caused by the VFD. The results based on a computer aided circuit simulation of the total actual system, with information obtained from the power provider and the user.

F. Pre-wired 3-position mechanical type Hand/Off/Auto (H-O-A) selector switch and speed potentiometer. Means to communicate hand, off, or auto position.

G. Power on light to indicate that the VFD is being supplied line power. Fault light to indicate that the VFD has tripped on a fault condition.
5.26.29 VARIABLE FREQUENCY DRIVES  
DESIGN AND CONSTRUCTION STANDARD

H. Plain English, backlit LCD digital display (code numbers and letters not acceptable) and keypad.

I. Internal self-diagnostics.

J. Speed control shall be from a 4-20mA, 0-10vdc or 3-15psi pneumatic signal.

K. Enclosures shall be NEMA-1 for indoor applications and NEMA 3R for outdoor applications.

L. Acceptable manufacturers and models:
   1. ABB ACH550.
   2. Danfoss FC 100.

M. Integral bypass switch that allows operation of the motor via line power in the event of VFD failure.

2.02 Warranty

A. 36 months from the date of certified start up. Include all parts, labor, travel time and expenses.

B. Local factory certified technicians for 24 hours, 7-day a week service. Throughout the warranty service period, response within 24 hours of initial contact for service.

C. Guaranteed spare parts availability to the University for a minimum of fifteen (15) years from date of purchase. Price escalation for spare parts not to exceed 10% per year over the fifteen (15) year duration

2.03 Training

A. On-site instruction included with each VFD and within 30 days of start-up. Factory trained and certified instructor. All training aids shall be provided by trainer. Content to include care, troubleshooting, servicing, and operation of the equipment and systems installed.

B. Classroom, on-site and in-the-field instruction.

2.04 Start-Up

A. Factory trained and certified technician shall check the installation, start the VFD's and place them into operation. Start-up within two weeks of notification.

B. Certified start-up report.

2.05 Communications
A. EIA-485 and EIA-232 ports as standard.

B. Communicate with PLC's, DDC's, Metasys N2 bus, BACnet, and other communication protocols. Components included for interface with the selected Building Automation System.

C. Serial port to download drive parameters and fault logs.

D. Programmable inputs and outputs.

PART 3: EXECUTION

3.01 Design Requirements

A. The 50% Contract Document review submission shall include specifications and details for VFD's.

B. Statement of deviations from standards. Deviations approved by the University.

C. Incorporate the University’s standard VFD documents and details into project contract documents.

D. Show VFD locations on mechanical plans. Ensure adequate mounting space and floor area including service access. VFD preferred location is adjacent to and within the same room as equipment served.

3.02 Coordination

A. All design work shall be coordinated between electrical, mechanical and the University.

B. Coordinate the following VFD options with the University:
   1. External bypass switch to operate equipment while VFD is inoperative or being maintained.
   2. Communications interface with building and temperature controls.
   3. Input line reactors for harmonic suppression.
   4. Output line reactors for motor protection.
   5. 6, 12 or 18 pulse shifting transformer or Active Harmonic filtering (AHF) to minimize total harmonic distortion.
   6. Removable VFD keypad with LCD and memory storage.
   7. External Three contactor DRIVE/OFF/BYPASS/TEST SWITCH that allows operation of the motor via line power in the event of VFD failure.

END OF STANDARD
5.26.30 POWER GENERATING AND STORING EQUIPMENT
DESIGN AND CONSTRUCTION STANDARDS

PART 1: GENERAL

1.01  Engine Generators

This section of the standard includes design requirements for a packaged electric generator set to provide emergency and stand-by power.

1.02  Enclosed Transfer Switches

This section includes automatic transfer switches and bypass/isolation switches for systems rated 600 volts and less. The transfer switches shall be the means of automatically switching the Emergency Electrical System loads between normal and emergency power. This applies in the instances where an emergency generator is a part of the project scope.

1.03  Emergency System

A. The emergency system shall consist of an emergency panel fed from an automatic transfer switch which shall have a normal feeder from the new facility and an emergency feeder from the University's existing 480 volt, 4 wire grounded with emergency system. This system shall be provided even if no emergency power source is currently available.

B. Emergency power shall be provided for the following: All stairwell lighting Fixtures in corridors and public areas that are considered "night lighting", Elevator lighting, Egress lighting, Fire Alarm System Communication system, Sump pumps, Stairwell pressurization fans.

C. Emergency power shall be provided for one elevator motor in each bank of elevators in high rise buildings as defined by the National Fire Codes. A keyed selector switch shall be located on the ground floor allowing rescue personnel to select any elevator in the bank.

D. If, due to size and location, emergency power is not available from the University's emergency power system or by generator set, provide individual equipment, i.e. light fixtures with individually mounted battery packs.

E. Fire pumps shall be connected to the emergency system per applicable codes.

   1. The generator set shall be a natural gas, four-stroke engine, and rated for continuous service at 480Y/277 Volts, grounded-wye, 60 Hz. Diesel generator will not be acceptable.

   2. Reference Utility Specifications

1.04  Related Standards

A. 6.26.05 Common Work Results for Electrical for related information on underground ducts and manholes, building wire and cable, raceways and boxes, cabletrays, full short circuit device, coordination and arc fault study, and enclosed switches.
B. Reference Natural Gas generators (KTE)

PART 2: PRODUCTS

2.01 Engine Generators

A. The engine should be capable of developing adequate brake horsepower operating on 900 BTU gas, at a potential delivery rate of 6628 CFH, to drive a generator delivering the rated kW plus 5% on a continuous basis for ambient conditions of 110 degrees F and 1,200 feet above sea level for the duration of utility interruptions.

B. The natural gas fired engine-generator set shall be rated not less than specified kW/kVA at 0.8 power factor on a continuous basis. The AC synchronous generator shall be rated 60 Hz, 4 pole, revolving field, 1800 RPM for use with a 480Y/277 VAC, 3 phase, 4 wire electrical system. The alternator shall be oversized and rated for at least 125% of the specified kW/kVA at 80 degree rise for non-linear load considerations.

C. The engine-generator set shall be capable of picking up a minimum of 100% nameplate and connected kW and power factor, less applicable derating factors, in one step with the unit at operating temperature.

D. The engine-generator set shall have a motor starting or surge KVA capability of three times the rated KVA based upon a recovered sustained RMS voltage drop of no more than 10% of no load voltage with the specified load KVA at or near zero power factor. Maximum instantaneous voltage dip shall not exceed 30% at this load and power factor level. If associated with serving a fire pump, the maximum dip shall not exceed 15%.

E. The generator set shall be connected to the power system through an automatic transfer switch and shall be considered a separately derived power source for grounding purposes.

F. Acceptable manufacturers:

1. Cummins Power Generation
2. Caterpillar Holt
3. Owner approved equivalent

G. Sequence of Operation

1. When normal utility power is available, the Emergency Power System shall receive power from the normal power distribution system and transmit normal utility power over the Emergency Power System.
2. Upon failure of the normal utility source, the engine shall start automatically and the automatic transfer switch shall switch the supply and local engine generator set power to the Emergency Power System.
3. Upon restoration of normal utility power, the controls shall automatically reverse the shutdown procedures with time-delay-on-retransfer and time-delay-on-engine-shutdown.
H. Remote Alarm Annunciator:
   1. Provide a remote alarm annunciator with visual indication and dry type Form C
      contacts to indicate and provide remote status indication of the generator.
   I. Batteries: Batteries shall be 12-volt heavy-duty lead acid type.

J. Battery Charger: Shall have 120V input and be capable of restoring a pair of fully
   discharged batteries to a fully charged condition in 12 hours.

K. Jacket Water Heater: Provide a separate 120 or 208 Volt circuit from normal power for
   the engine jacket water heater and controls.

L. Generator Heater: Provide a separate 120 or 208 Volt circuit from normal power for the
   generator heater and controls.

2.02 Automatic Transfer Switches

A. The switch shall be rated at 480Y/277 VAC, 60 Hertz 4 wire operation. The transfer
   switch shall be contactor type. Molded case circuit breakers functioning as transfer
   switches shall not be allowed. The switch shall be enclosed in a NEMA 1 steel cabinet.
   The front door shall be key lockable. All components shall be front accessible.

B. The automatic transfer switch shall be designed such that a maintained neutral position in
   which the load is not connected to either source. The switch mechanism shall be designed
   to permit use of all three positions during programmed transitions on both transfer and
   retransfer.

C. The switch shall be designed with generator start controls.

D. The design shall require that the transfer switch have an isolation-bypass feature. This
   feature allows the removal of the transfer switch mechanism for repair without
   interruption to the load.

E. Reference Utility Specifications.

PART 3: EXECUTION

3.01 Engine Generators

A. Site plan drawing shall indicate location of generator with pad drawn to scale.

B. Site plan shall also clearly indicate conduits from generator to automatic transfer switch.
   Layout shall also include the required conduits necessary for controls and accessories.

C. Building floor plans shall indicate location of remote annunciator panel and required
   conduit and circuit connectivity.

D. One-line diagram shall indicate generator size, automatic transfer switch in normal
   position, feeder sizes and generator main breaker size.
E. Professional Service Provider (PSP) shall provide pad construction details. PSP is responsible for coordination with Civil/Structural Engineer.

3.02 Automatic Transfer Switches

A. Normal and emergency circuits feeding into the switch shall be protected by molded case circuit breakers.

B. The continuous duty ampere rating shall be for the complete downstream load.

C. Drawings shall indicate location, drawn to scale in the electrical rooms. An alphanumeric designator consistent with the standards of The University shall be applied to the room layout and the single line diagram. The single-line diagram shall show the continuous duty rating, both sources of power with appropriate feeders and the switch shown in the normal operating position.

D. The PSP shall coordinate with The University on precise sequence of operation, but the minimum baseline requirement shall adhere to the following:

1. Undervoltage Sensing: All phases of normal and emergency power shall be monitored with solid state undervoltage sensors. When normal load voltage drops to 80% of normal, transfer switch shall initiate emergency generator and transfer when emergency source is at minimum of 90% voltage and proper frequency.

2. Overvoltage Sensing: All phases of normal and emergency power shall be monitored with solid state adjustable overvoltage sensors. These sensors shall be adjustable for pick-up settings from a minimum of 100% to a maximum of 130% (+/- 5%), with a dropout of 5% (+/- 1%) of nominal voltage above the pick-up setting. An adjustable time delay of 0.5 – 2.2 seconds shall be provided.

3. Frequency Sensing: Solid state and adjustable for pickup of +/- 4% to +/-20% of nominal frequency. Dropout shall be +/- 5% of nominal wider than the pick-up frequency bandwidth. The time delay shall be adjustable from 0.1 15 seconds.

4. Retransfer: Retransfer to normal power shall occur when normal source has stabilized to 95% voltage for minimum of 15 minutes. Control shall be adjustable from 0 – 30 minutes. Appropriate controls for cooling down generator shall be provided prior to stopping (factory set at 30 minutes.)

END OF STANDARD
PART 1: GENERAL

1.01  Luminaires

A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design for new construction and renovations. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through life cycle cost (LCC) analysis and submitted to the University for approval.

B. Lighting design shall meet the requirements of the ASHRAE 90.1-2010 as currently adopted by the State of Texas Energy Code and meet the recommended illumination levels of the current edition of the Illuminating Engineering Society of North America (IESNA) Lighting Handbook.

C. In addition the lighting design shall target lighting power densities a minimum of 25% below the values allowed in the ASHRAE 90.1-2010 Standard. For fluorescent lighting systems in new construction (or renovations with fixture replacements) and with typical ceiling heights of approximately 9 feet, this can be accomplished by using light colored wall finishes and 2-lamp high efficiency fixtures with the components specified below.

D. For renovations where fixture replacements are not desirable, high efficiency retrofit kits are available from fixture manufacturers and third party sources that provide efficiencies equal to new high efficiency fixtures.

E. Fluorescent luminaires that utilize double-ended lamps and contain ballast(s) that can be serviced in place shall have a disconnecting means either internal or external to each luminaire.

F. Do not use low pressure sodium, mercury vapor or standard incandescent lamps.

PART 2: PRODUCTS

INTERIOR LUMINAIRES

2.01  Fluorescent Lighting

A. Linear & Compact Lamps
   1. All linear fluorescent lamps installed within conditioned spaces shall be 4-foot straight tube, F28T8, 28-watt, high lumen output or 2-foot linear tube, F17T8 high lumen output type.
   2. All fluorescent lamps installed in unconditioned or refrigerated spaces shall be 4-foot straight tube, F32T8, 32-watt, high lumen output type.
3. All linear 17, 28 and 32 watt fluorescent lamps shall have a minimum rated life of 24,000 hours at 3 hours/start (instant start ballast), 95% or higher lumen maintenance.
4. CCT of 4,100K and CRI ≥80
5. No eight-foot lamps allowed. Use combination of 4-foot lengths in 8 foot fixtures.
6. All screw and plug-in compact type fluorescent lamps installed within conditioned spaces shall operate by an electronic ballast with a power factor ≥60% for screw-in, ≥95% for plug-in, have a minimum rated lamp life of 10,000 hours at 3 hours/start, CCT of 4100K and CRI ≥80. CFLs installed in unconditioned spaces will have the additional requirement of being operated by an electronic ballast designed for unconditioned spaces.

B. Ballasts for Linear Lamps.

1. Fluorescent ballasts shall be high frequency (see item 12 below), U.L. approved, CBM certified to operate as specified one, two or three T8 lamps.
2. Shall be integrated circuit type electronic constant wattage, constant light output
3. Shall have a power factor ≥95%
4. Shall have Class A sound rating
5. Shall be Class P thermally protected with automatic reset
6. Shall have a current crest factor less than 1.5
7. Shall have a total harmonic distortion (THD) <10%.
8. Where not separately switched three or four lamp fixtures may contain 3 and 4 lamp ballasts.
9. Ballast factor shall be 0.77 or 0.78 for Low Powered ballasts, between 0.85 and 0.90 for Normal Powered ballasts, and greater than 1.12 for high output ballasts.
10. Shall be instant start and classified as NEMA premium efficiency
11. Shall be designed to accommodate multiple voltage input, have built in anti-striation technology and utilize parallel lamp operation circuitry
12. Ballasts shall further be designed such that the output frequency to the lamps is high enough (typically 40 kHz or greater) so as to not interfere with common infrared devices.

C. Prismatic acrylic diffusers for fluorescent fixtures shall be A12 pattern and at least 1/8” thick. Do not use styrene lenses.

D. Troffers with air handling capability are not allowed unless prior approval is given by the University.

2.02 HID Lighting

A. Mercury vapor and high & low pressure sodium lamps/luminaires are not allowed, only metal halide.

B. “Open type” fixtures should not be used indoors due to safety concerns.
C. PULSE Start Lamps
   1. Minimum rated lamp life shall be 20,000 hours for lamps >150 watt and 15,000 hours for lamps ≤150 watt
   2. CCT of 4000K and CRI ≥80

D. PULSE Start Ballasts
   1. HID ballast shall be multi-tap encased and potted thermally protected with a power factor ≥90%, constant wattage regulating and autotransformer type.
   2. Ballast ambient operating temperature range shall be 20 to +130°F. Ballasts shall be compatible to the lamps chosen for specific burning position, and compensate for the loss in efficiency.
   3. Provide isolation mounting and insulation of HID ballasts to reduce sound transmission or radiation.
   4. Each HID ballast shall have a fast acting primary inline fuse built into the fixture assembly by the manufacturer

2.03 LED Lighting

A. Screw-in retrofit lamps
   1. Shall meet DOE’s Energy Star or Design Light Consortium performance criteria for qualified screw-in or pin-based LED lamps.
   2. Shall have Lamp CCTs conforming to ANSI C78.377A color binning and utilize a 4 step MacAdam Ellipse Algorithm binning process (Philips Optibin or equal) within each retrofit lamp for greater CCT consistency.
   3. The CCT shall be 4000K unless otherwise approved by the University. The CRI shall be ≥80.
   4. Each lamp shall have a power factor ≥90%.
   5. Each lamp shall have total harmonic distortion (THD) <10%
   6. Shall be tested in accordance with LM-79-08 electrical and photometric measurements. Provide to the University, test results of each unique lamp.
   7. Shall be tested in accordance with LM-80 lumen depreciation test. Provide to the University, test results of each unique lamp. The L70 rated life result shall be a minimum of 25,000 hours for MR11, 16 and candelabra lamps; 40,000 hours for PAR 20, 30, 38 and BR30 lamps.
   8. Shall carry a 3 year minimum product warranty covering failure of ALL electrical components.

B. Luminaires
   1. The luminaire manufacturer shall be registered as a DOE Quality Advocate.
   2. Shall meet DOE’s Energy Star or Design Light Consortium performance criteria
   3. The luminaire manufacturer shall provide the manufacturer’s name of the LED being used in the luminaire.
   4. Shall be UL, or ETL, listed and be furnished complete with LEDs and power supplies.
5. LED light source packages, arrays or modules used in the luminaire shall be tested in accordance with LM-80 lumen depreciation test. Provide to the University, test results of each unique package, array or module. The L70 rated life result shall be a minimum of 50,000 hours.
6. Shall be tested in accordance with LM-79-08 electrical and photometric measurements. Provide to the University, test results of each unique luminaire.
7. The CCT shall be 4000K unless otherwise approved by the University. The CRI shall be ≥80.
8. Each luminaire shall have a power factor ≥90%.
9. In instances where the LED sources are to be mounted directly into the architecture, such as installing a strip LED by using an adhesive tape, the LED manufacturer shall provide a recommended heat sink volume adequate to achieve rated life at L70.
10. Each luminaire shall carry a 3 year minimum product warranty covering failure of ALL electrical components.

C. Power Supplies
1. LED power supplies shall operate LEDs within the current limit specification of the manufacturer
2. Shall operate from 60Hz input source and have input power factor >90% and a minimum efficiency of 70% at full rated load of the driver.
3. Shall have short circuit and overload protection.
4. Shall have a minimum starting temperature of 0°F and a maximum case temperature rating of at least 70°C.
5. Power supply output shall be regulated to +/-5% across published load range.
6. Shall have a Class A sound rating.
7. Shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.
8. Shall contain no PCBs.
9. Shall carry a 3 year minimum warranty from date of manufacturer against defects in material or workmanship, including a replacement, for operation at or below the maximum case temperature specification. (For LED lamps and internal power regulation components for defects resulting in a fixture lumen depreciation >30%.)
10. Dimmable power supplies shall allow the light output to be maintained at the lowest control setting (prior to off) without dropping out.

D. Exit Signs
1. Fixtures shall be LEC or LED, hard wired, perimeter or edge lit and preferably green on clear background type.
2. If a back-up circuit is not available, then exit sign must be a battery back-up type with self-diagnostics that shall perform both 30-day and annual 90-minute tests with LED indication.
3. Where it is not possible to run conduit, photo luminescent type may be used but will require prior University approval.
4. Tritium gas exit signs are not allowed.

2.04 Induction Lighting

A. Lamps
   1. Minimum rated life of 100,000 hours
   2. CCT of 4100K and CRI ≥80

B. Ballasts
   1. Shall have Class A sound rating
   2. Shall have a UL Listed Class P, Type 1 outdoor
   3. CSA certified
   4. Shall have a 70 °C maximum case temperature
   5. Shall have ANSI C62.41 Category A transient protection
   6. Shall be designed to accommodate multi-voltage input
   7. System efficacy ≥70 LPW
   8. Total harmonic distortion <15%
   9. Power factor >90%

2.05 Exterior Luminaries

A. The performance criteria is the same as interior luminaires plus the additional or “in lieu of” criteria below:
   1. Lamp CRI shall be ≥70 for metal halide and LED light sources.
   2. Shall be durable, corrosion resistant fixtures that are readily maintainable and have minimal luminaire O&M costs
   3. Shall have light cut-off capability in order to minimize light pollution

B. The following luminaire descriptions are to establish design intent and to set a standard of quality. All luminaires shall be UL listed for wet or damp locations depending on the application.
   3. Area and Parking Lot Luminaires: Die-cast aluminum with nominal 1/8” wall thickness minimum cutoff luminaire equipped with a pulse-start metal halide lamp. The finish shall be corrosion-resistant polyester powder coating. If LED type is proposed, each will be evaluated on a case by case basis. See Design Standards Matrix for further information.
4. Pedestrian Walk, Plaza Light Standard (NO EXCEPTIONS to the following criteria:)
   a) **WAU15DMHMDA8TDC4** Fixture, Washington Series, Utility Grade, 150 Watt Metal Halide, Medium Base Socket, Multivolt (120/208/240/277) Factory wired at 277 Volt Only, (Q015543) Fixture Painted To Match Tiger Drylac Number RAL 7039, Symmetric Type V Optics, (Q015543) Trip Painted to Match Tiger Drylac Number RAL 7039, Spike Finial.
   b) Listed below are the components of the above mentioned pole and luminaire:
      i) **NY13C17CACS** Pole, North Yorkshire, Fluted Cast, Cast Aluminum Post, 12’ 7” height, Custom Painted to Match Tiger Drylac RAL #7039.
      ii) **WASH8-REPL** Optics, Type V, Symmetric, Lunar Optics Bottom Glass Assembly.
      iii) **(AOL-18189)3370-AR7039-CTN** Optics, Top Relamping Glass with Trim Painted to match Tiger Drylac RAL #7039, Spike Finial.

PART 3: EXECUTION

3.01 **Interior Lighting**

   A. Professional Service Provider (PSP) shall provide a room by room, computer generated photometric lighting design for approval. All calculations and data shall be presented in the design development and construction documents. Also provide tabulated results of lighting power density calculations in W/sf showing the actual, the ASHRAE 90.1-2010 allowable, and the 25% savings target per 1.01, C. Increased energy consumption of 10% or more must be reported in accordance with State Energy Code reporting procedures. REFER: http://www.seco.cpa.state.tx.us/tbec/statefunded.php.

   B. Applications other than standard general purpose lighting (T8 lamps), require presentation to the University. Use of specialty or incandescent lamps requires prior University approval. Minimize the number of different lamp types used.

   C. Emergency light fixtures shall have the LED emergency light indicator mounted such that it is visible from the ground.

   D. Lay-in type fluorescent fixtures must have supports to structure at two opposing corners minimum. These supports are to be attached to the fixture housing. Ceiling supports are in addition to these supports.

   E. Outlet boxes for lighting shall be 4” square or 4” octagon boxes mounted to the structure. These boxes may feed up to 4 light fixtures individually so that each fixture can be taken out of service without affecting the remainder of a circuit. Do not daisy chain light fixtures.
F. Stairwell light fixtures shall be located such that they may be reached safely with no more than an 8-foot ladder.

G. Require in-line fuses in fixtures which are not locally switched or where lighting circuit should not be turned off for safety reasons. (i.e. stairwells)

H. Egress lighting is required to illuminate an average of 1 foot candle in all paths of egress. Egress lighting shall be powered by emergency power automatic transfer switch (ATS) dedicated to Life Safety Loads. In buildings where emergency power circuits do not exist, install self-diagnostic emergency fluorescent ballasts and/or emergency lighting units. Ballasts shall provide a minimum of 90 minutes of code required emergency lighting at compliant illumination levels. Self-diagnostics shall perform both 30-day and annual 90-minute tests with LED indicator.

Battery packs for emergency ballasts shall be rated for high temperature operation and have a five year warranty. Battery audible alarms shall be disabled.

I. Lighting Designer shall verify installation meets design intent and operates properly unless a commissioning agent assumes this responsibility.

3.02 Exterior Lighting

A. All walkways, sidewalks, and parking lots shall be illuminated to levels recommended by the IESNA or as required to meet the University’s security needs, whichever is higher.

B. Upon request from Utilities & Energy Management Electrical Distribution Division, all engineering calculations of illumination levels and lighting power density shall be presented in construction documents.

C. Exterior lighting should be accomplished using lighting standards and wall packs. Lighting bollards, step and handrail lighting, tree lighting, and in-grade fixtures are not allowed.

D. Exterior and site lighting shall be shown on site plan. List distances between poles, fixtures and other site lighting devices.

E. Provide pole mounting height and pole base installation detail.

F. Lighting Designer shall verify installation meets design intent and operates properly unless a commissioning agent assumes this responsibility.
## Design Standards Lighting Matrix

<table>
<thead>
<tr>
<th>Use of Area</th>
<th>Type of Fixture</th>
<th>Lamps</th>
<th>Fixture Efficiency</th>
<th>Recommended average light levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom, library, office</td>
<td>Lensed or louvered fluorescent/LED</td>
<td>2 – T8, 28 or 17 watt, 4100K LED, 4000K</td>
<td>Fluorescent ≥80%</td>
<td>45 to 55 foot candles at work surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥90 LPW</td>
<td></td>
</tr>
<tr>
<td>Kitchen, machine shop, laboratory</td>
<td>Lensed or wrap around fluorescent/LED</td>
<td>2 to 3 – T8, 28 or 17 watt, 4100K LED 4000K</td>
<td>Fluorescent ≥80%</td>
<td>50 to 65 foot candles at work surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥90 LPW</td>
<td></td>
</tr>
<tr>
<td>Conference room</td>
<td>Lensed or louvered fluorescent/LED</td>
<td>2 – T8, 28 or 17 watt, 4100K LED, 4000K</td>
<td>Fluorescent ≥80%</td>
<td>35 to 45 foot candles at work surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥90 LPW</td>
<td></td>
</tr>
<tr>
<td>Optional recessed can</td>
<td>CFL 4100K LED 4000K</td>
<td>Fluorescent ≥60%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥40 LPW</td>
<td></td>
</tr>
<tr>
<td>Lobby, lounge, reception, copy room, exhibit</td>
<td>Lensed or louvered fluorescent/LED</td>
<td>2 – T8, 28 or 17 watt, 4100K LED, 4000K</td>
<td>Fluorescent ≥80%</td>
<td>20 to 35 foot candles at 30”AFF</td>
</tr>
<tr>
<td>hall, dining, food court, locker, study and</td>
<td></td>
<td></td>
<td>LED ≥90 LPW</td>
<td></td>
</tr>
<tr>
<td>common area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restroom</td>
<td>Lensed fluorescent/LED</td>
<td>2 – T8, 28 or 17 watt, 4100K LED, 4000K</td>
<td>Fluorescent ≥80%</td>
<td>20 to 25 foot candles at 30”AFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥90 LPW</td>
<td></td>
</tr>
<tr>
<td>Corridor with exhibit space</td>
<td>Lensed or louvered fluorescent/LED</td>
<td>2 – T8, 28 or 17 watt, 4100K LED, 4000K</td>
<td>Fluorescent ≥80%</td>
<td>30 to 40 foot candles at floor level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥90 LPW</td>
<td></td>
</tr>
<tr>
<td>Optional recessed can</td>
<td>CFL 4100K LED 4000K</td>
<td>Fluorescent ≥60%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥40 LPW</td>
<td></td>
</tr>
<tr>
<td>Stairway, corridor</td>
<td>Commensurate with architectural finish of space/LED</td>
<td>2 – T8, 28 watt, 4100K LED 4000K</td>
<td>Fluorescent ≥80%</td>
<td>15 to 25 foot candles at floor level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LED ≥90 LPW</td>
<td></td>
</tr>
<tr>
<td>Storage, Mach/Elect room</td>
<td>Industrial fluorescent</td>
<td>2 – T8, 28 watt, 4100K</td>
<td>Fluorescent ≥80%</td>
<td>20 to 30 foot candles at 30” AFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 5.26.50 – INTERIOR & EXTERIOR LIGHTING
#### DESIGN AND CONSTRUCTION STANDARD

<table>
<thead>
<tr>
<th>Location</th>
<th>Light Source or Luminaire Details</th>
<th>Candelas at Work Surface or Ground Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer room</td>
<td>18 cell 3” parabolic i.e. Lithonia 2PM3N series, 2 – T8, 28 watt, 4100K, Fluorescent ≥65%</td>
<td>35 to 45 foot candles at work surface</td>
</tr>
<tr>
<td>Exhibit</td>
<td>LED or fluorescent wall wash or track, Varies, Varies based on application</td>
<td>Varies based on application</td>
</tr>
<tr>
<td>Pedestrian walk</td>
<td>Pole-mount with cut off (see item B. 4 in Section 2.02 Exterior Luminaires for specifics), Pulse start 150 watt MH, 4000K</td>
<td>NA</td>
</tr>
<tr>
<td>UT shuttle stops</td>
<td>Varies, Pulse start MH or LED, Varies</td>
<td>10 to 20 foot candles at ground level</td>
</tr>
<tr>
<td>High bay areas</td>
<td>High bay fluorescent, Varies-T8, 28 watt, 4100K, Fluorescent ≥80%</td>
<td>Varies based on function of space</td>
</tr>
<tr>
<td>Building exterior wall packs</td>
<td>Cut-off wall pack with fluorescent or LED light source, CFL 42 watt, 4100K, LED 4000K, Fluorescent ≥80%</td>
<td>1 to 2 foot candles at ground level</td>
</tr>
<tr>
<td>Surface mounted canopy luminaires</td>
<td>Vapor tight, 2 – T8, 32 watt, 4100K, LED 4000K, metal halide 4000K, Fluorescent or metal halide ≥80%</td>
<td>10 foot candles or IES recommended level</td>
</tr>
<tr>
<td>Areas requiring scaffolding to access</td>
<td>LED or induction, LED 4000K, Induction 4100K, Varies based on application</td>
<td>Varies based on application</td>
</tr>
<tr>
<td>Parking garage, interior</td>
<td>LED or metal halide, LED 4000K, metal halide 4000K, Varies based on application</td>
<td>Varies, see light control standards for further details</td>
</tr>
<tr>
<td>Area &amp; parking lot lighting</td>
<td>Pole-mount with cut off, Pulse start MH or LED, LED ≥75 LPW for typical shoebox type (deduct 10-15 LPW for house side shield optics)</td>
<td>8 to 10 foot candles at ground level</td>
</tr>
</tbody>
</table>

**END OF STANDARD**


5.26.50-9
PART 1: GENERAL

1.01 This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 Standards
   A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standard documents.
      1. NEMA MG 1 - Motors and Generators.
      2. ANSI/IEEE 112 - Test Procedures for Motors / Generators.
      3. UL 1004 - Motors, Electric.
      4. UL 674 - Motors, Generators, Electric, for Use in Hazardous Locations: Class I, Groups C and D; Class II, Groups E, F, and G.
      5. Provide minimum nominal motor efficiency per ASHRAE 90.1 2010.
      6. ASHRAE 90.1 2010, Section 6 requires that some electric motors as low as 5 hp employ Variable Speed Drives (as one option) to reduce the motors electrical demand. Review section 6 to determine if any specified motors are applicable and need to meet this criteria.

1.04 Warranties
   A. Vendor shall provide the standard form of written guarantee and warranty covering defects in materials and workmanship for the equipment. Said guarantee and warranty shall be for a period of one year from the date of final acceptance of the equipment by The University. Date of acceptance shall be defined as the date that The University assumes operation of the unit.

PART 2: PRODUCTS

2.01 Motors Less Than 1/2 Hp
   A. Unless otherwise specified, motors less than 1/2 hp shall be squirrel-cage, induction type, capacitor start with copper stator windings as the Standard low-horsepower motor.

   B. Motors shall be continuously rated with 1.15-service factor for operation at 115 volts, single-phase, 60 Hz.

   C. The driven load for constant speed applications shall not exceed the motor's continuous nameplate rating, exclusive of any service factor, under any normal operating condition.

2.02 Motors Larger Than 1/2 Hp Through 250 Hp
   A. Motors shall be 3-phase, continuously rated, squirrel-cage, random-wound copper, induction motors designed for 460 volt, 60 Hz operation. Provide motors rated for continuous operation with 1.15-service factor. Motors 7.5 HP and larger shall be 3-phase 480 volt only.
B. Provide motors with Class F insulation and a Class B temperature rise based on 40 degrees C ambient. When ambient temperatures exceed 40 degrees C, temperature rise shall be adjusted according to MG 1-12. Locked Rotor Current: Provide motors with locked rotor starting currents not exceeding Code L under 3 hp, Code K for 3 and 5 hp, Code H for 7-1/2 and 10 hp, and Code G for 15 hp and above.

C. Provide motors meeting the energy efficiency and power factor requirements of ASHRAE 90.1 2010 Table 6.8 Minimum Equipment Efficiency Tables for minimum nominal efficiency, when tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B.

D. Provide motors rated for continuous operation with 1.15-service factor. For constant speed motors, the driven load shall not exceed the motor's brake horsepower nameplate rating, exclusive of any service factor, under any normal operating condition.

E. Provide all TEFC motors with anti-friction grease lubricated ball bearings, with a bearing AFBMA B-10 life of 100,000 hours, and sealed from the environment. Provide factory lubrication of all motors prior to shipment. Provide all grease-lubricated bearings with relief fittings.

F. Provide all ODP motors with sealed anti-friction grease lubricated ball bearings, with a bearing AFBMA B-10 life of 100,000 hours. Provide factory lubrication of all motors prior to shipment. Provide all grease-lubricated bearings with relief fittings.

G. Motors which are located outside or wherever specified shall be provided with space heaters sized to prevent moisture condensation, rated 120 volts, with a separate conduit box for heater leads only.

H. For motors 5 horsepower and larger, provide a snap action normally closed Klixon embedded in the stator winding at the 12:00 position with tee leads wired out to the wiring compartment. The temperature of the Klixon shall be set for 25% of the insulation temperature rating.

I. Provide motors with conduit boxes that are fully rotatable, diagonally split, including gasket between cover and box, and box and frame, with threaded hubs and a grounding lug located within the box for ground conductor connection.

J. Provide nameplates of stainless steel or other approved corrosion resistant material to provide a permanent legible marking, containing NEMA data plus guaranteed minimum efficiency. Attach nameplates and connection plates to the motor frame by rivets or screws.

K. Variable torque, inverter duty rated motors shall be provided for variable speed applications. Insulated bearings shall be used for motors driven by variable frequency drives.

2.03 Motor Types
A. The following Standard motor types shall conform to the following requirements:

1. **Horizontal Dripproof**: Provide horizontal motors with an enclosure that meets NEMA Standard MG 1 for open, dripproof construction. Provide screen over all air openings.

2. **Horizontal Totally Enclosed Fan-Cooled**: Provide totally enclosed fan-cooled (TEFC) motors with frame sizes 182 and larger with cast iron frames and end shields. Smaller frame sizes may be constructed of rolled steel with cast metal end shields. Provide motors with condensate drain holes. For frame size 286 and larger, provide automatic breather/drain device in drain hole.

3. **Vertical Weather Protected Type I**: Provide vertical motors with an enclosure that meets NEMA Standard MG 1 for weather protected Type I (WP-I) enclosure. Provide screens over all air openings.

4. **Vertical Totally Enclosed Fan-Cooled**: Provide vertical motor with an enclosure identical to the requirements for the horizontal TEFC motors.

5. **Explosion proof**: Provide all horizontal and vertical motors with TEFC explosion proof enclosures, UL listed for Class 1, Division 1, Group D hazardous atmosphere. Provide motors manufactured by Reliance Electric, or equal.

6. **Submersible**: Submersible motors UL listed for explosion proof atmospheres in accordance with subsequent sections of this specification. In addition, provide submersible motors with two mechanical seals; the lower one outside the motor and protecting the upper one, which is in an oil filled chamber. Provide moisture detector probes in the oil filled seal chamber to indicate the presence of moisture in the seal chamber. Provide a temperature detector and switch rated 3 amperes, 120 volts minimum, set to operate when the internal motor temperature exceeds a preset limit. Provide any relays or solid-state controls for separate mounting.

7. **Horizontal, Totally Enclosed, Fan-Cooled, Severe Duty**: Provide horizontal (TEFC), severe duty motors suitable for contaminated environments, including gasketed conduit box, stainless steel drains, double-shielded bearings, and corrosion resistant paint. Provide motors manufactured by Reliance Electric SXT-XT-XE, Century Type SCE E-Plus, or equal.

8. **Vertical, Totally Enclosed, Fan-Cooled, Severe Duty**: Provide vertical (TEFC), severe duty motors with the requirements identical to horizontal (TEFC), severe severe duty motors, above.

2.04 **Motors For Use With Variable Frequency Drives**

A. Motor Application Considerations:

1. **NEMA Standard MG1 definite purpose inverter duty rated motors** shall used for all variable frequency drive installations. The inverter duty motors shall be able to withstand voltages greater than 1600 volts peak and rise times of 0.1 microsecond.

2. Applications where the motor specification does not meet NEMA MG1 Part 31 (1600V peak and 0.1 microsecond rise time), and the cable length between the inverter and motor exceeds the drive manufacturer recommended maximum cable length; load sideline reactors shall be used. The load sideline reactor shall be design and constructed to operate with variable frequency inverter drives with switching frequencies up to 20 Khz. Line reactor insulation dielectric strength shall be greater than or equal to 4000 volts and shall carry a UL506 & UL508 approval.

3. Insulated or isolated bearings shall be used for the inverter duty rated motors.
4. The inverter duty motor shall be constructed with triple film wire, increased winding slot insulation, increased insulation between phases, and increased first turn insulation. The inverter duty motor shall use slot fillers as required to avoid loose windings.

5. The inverter duty motor insulation class shall be class F insulation and a class B temperature rise based on 40 degrees C.

6. The inverter duty motor nameplate shall indicate that the motor is an inverter duty motor.

2.05 Motors and Motor Starters

A. Specific motors are not generally specified within this section. Refer to appropriate mechanical design requirements for specifics on motors.

B. Coordinate with mechanical designer to require only NEMA premium efficiency motors with guaranteed efficiency at least equal to NEMA standards.

C. Motors 5 HP or smaller shall have sealed, lubricated-for-life bearings. Motors 7 1/2 HP or larger shall have antifriction ball or roller bearings, oil or grease lubricated.

D. Motors 10 HP and larger shall be 480V, 3 phase; Motors 7 1/2 HP to 1 HP can be 208V, 3 phase motors less than 1 HP can be 120V, single phase.

E. Motor Starters: Motor starters shall contain a NEMA integer sized contactor; one overload relay per phase; 120 Volt coil for external control power; interlock on disconnect switch to de-energize external voltage control. Where external control power is not provided, include a fused control power transformer, 120 Volt secondary mounted in the starter cabinet only. Starter shall provide for the field installation of up to 3 NO and 4 NC interlocks in addition to the hold-in interlock. Fan starters are to have safety switches on the line side of the motor and/or Variable Frequency Drive. The safety switch is to be located inside large air handler units and close to the air handler unit on small units. Where start/stop functions are controlled through control system, provide a relay in the automatic circuit of the control coil such that a 24V signal will actuate the starter.

PART 3: EXECUTION

3.01 Pump Motor Requirements:

1. Wiring Requirements:
   (a) Connect all pump motors rated at 25 amps or below with a flexible power cord no longer than 3 feet. The cord shall be hard service SO cord, rubber insulated with a neoprene jacket, rated at 90° C, 600V, oil resistant. It should be sized for the motor nameplate amperage:
   (b) Duplex sump pumps and condensate return pumps should be wired so that each pump is on a separate dedicated circuit. A mechanical alternator is to be provided to alternate operation of the pumps. There should be three floats in the sump; the lowest to energize the first pump, the next highest to energize both pumps, and the highest to operate a N.O. set of contacts for alarm purposes.
(c) Some pumps may require emergency power. Coordinate with University of Texas representative for special requirements.

2. Electrical engineer to coordinate cord and NEMA plug/receptacle requirements with mechanical engineer and pump manufacturer.

3.02 Motors and Motor Starters
   A. Variable speed drives shall be installed on the load side of the motor starter with an internal bypass.

   B. Single-line diagram shall indicate motor and motor starter size information. If motor starter information is shown on mechanical coordinate such that no discrepancies will exist.

   C. Circuit information for motors may be shown either on panel schedules or the floorplan, but not both to eliminate potential for discrepancies.

END OF STANDARD
27 00 00 COMMUNICATIONS

COMMUNICATIONS
SYSTEM DESIGN,
CONSTRUCTION AND
COMMISSIONING GUIDE

FACILITY SPECIFICATION GUIDELINE

University of Texas at Austin
INFORMATION TECHNOLOGY SERVICES
SECTION 27 00 00
COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Division 27 – Communications governs the infrastructure for the low-voltage information transport systems, which include voice, data, cable TV (CATV), and [audio/video,] [mass notification,] [distributed antenna] systems and their pathways.

B. Description of Work:

1. Furnish and install materials for the communications infrastructure systems as specified herein and as shown on the drawings. Upon completion, the systems shall be functioning systems in compliance with performance requirements specified.

2. The cabling specified and shown on the drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the Architect and the Owner, and at no additional cost to the Owner.

3. [This division also includes telecommunications cabling, connections, and equipment needed for the IP Video Camera Security System. Refer to Security System drawings for those locations, quantities and additional requirements.]

1.2 RELATED DOCUMENTS

A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

B. The following codes, associations, acts and agencies, as required by law:

1. Americans with Disabilities Act (ADA)
2. Federal Communications Commission (FCC)
3. National Electric Code (NEC)
5. National Fire Protection Association (NFPA)
6. Occupational Safety and Health Administration (OSHA)

C. The following standards:

1. American National Standards Institute (ANSI)
2. American Society of Testing Material (ASTM)
3. National Electrical manufacturers Association (NEMA)
4. Telecommunications Industries Association (TIA)
5. Electronic Industries Association (EIA)
6. Institute of Electrical and Electronics Engineers (IEEE)
7. Underwriters Laboratories (UL)
8. American Standards Association (ASA)

D. The following guidelines:

1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 DEFINITIONS

A. Advanced System Warranty – an extended telecommunications system warranty (15 years or greater) held either by the connectivity or cabling manufacturer directly with the owner for this project that guarantees product and performance of the entire cabling system for the warranty period. Refer to Warranty Requirements in Quality Assurance sub-section of this specification for additional information and requirements.

B. Communications Room – a generic term for an equipment room or telecommunications room.

C. Conveniently Accessible - being capable of being reached from floor or use of 8’ step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

D. Design Engineer – As defined for sections referring to telecommunications work only, the Design Engineer shall be the design consultant employed by the Owner for the purpose of observing the work of the Communications Subcontractor(s).

E. Entrance Room – A space in which the joining of campus and building telecommunications backbone facilities takes place.

F. Equipment Room – An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect, as well as audio/video and security equipment.

G. IDF – Intermediate Distribution Frame, also known as a Telecom munications) Room or Communications Room.

H. ITS Representative - For each project, the University of Texas at Austin will designate an official representative from ITS (Information Technology Services) Networking and Telecommunications.

I. Lead Telecommunications Installer – acting as the project manager for the Telecommunications Subcontractor for all telecommunications work in the construction documents (T-series drawings and specification sections 27 00 00 through 27 39 99), who shall be on-site at all times while Division 27 work is being performed. This individual shall attend all construction project meetings. Lead Communications Installer and Project RCDD may be the same person, but not necessarily. Refer to other subsections in this specification section (27 00 00) for qualifications, requirements and responsibilities.

J. Listed Communications Cable – A cable listed by the Underwriters Laboratory (UL) and acceptable to the local authority having jurisdiction as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to NEC Section 800 for listing types and additional requirements. Assume Outside Plant (OSP) Cable being supplied to the building is not listed.

K. MDF – Main Distribution Frame, also known as the Main Telecommunications Room.
L. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. Assume space above suspended/accessible ceilings is a plenum.

M. Plenum-rated – listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.

N. Point of Entrance (Building Entrance) - The point within a building at which the Outside Plant (OSP) communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the NEC.

O. Project RCDD – The Registered Communications Distribution Designer (RCDD) on staff of the Telecommunications Subcontractor responsible for ensuring all telecommunications work meets the construction documents (T-series drawings and specification sections 27 00 00 through 27 39 99) and the referenced codes, standards and guidelines. Refer to other sub-sections in this specification section (27 00 00) and other individual sections for Project RCDD qualifications, requirements and other responsibilities.

P. Subcontractor, Audio/Video – company responsible for all audio-video work in the construction documents (AV-series drawings and specifications sections 27 40 00 through 27 51 99)

Q. Subcontractor, Telecommunications – company responsible for all telecommunications work in the construction documents (T-series drawings and specification sections 27 00 00 through 27 39 99).

R. Telecommunications – in general, telecommunications refers to infrastructure/equipment needed for the voice and data communications systems.

S. Telecommunications Room - An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling. The Main Telecommunications Room may also be known as the MDF, and may be co-located with the building’s Entrance Room and Equipment Room. Other Telecommunications Rooms may be referred to as IDFs. Most Telecommunications Rooms will also house equipment for additional systems, such as security, cable television, and audio/video.

T. UL – Underwriters Laboratory

1.4 QUALITY ASSURANCE

A. Telecommunications Subcontractor Qualifications

1. Company Requirements

a) The Telecommunications Subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications. The Telecommunications Subcontractor shall be a company specializing in the design, fabrication and installation of integrated telecommunications systems.

b) Telecommunications Systems specified shall be engineered, assembled and installed under the direction of a pre-qualified Telecommunications
Subcontractor. Pre-qualification requirements shall include submittal by the Telecommunications Subcontractor to the Architect of the following:

1) List of previous projects of this scope and nature, including names and sizes of projects (to include square footage and construction cost – overall and that of the Telecommunications Subcontractor), description of work, times of completion, and names of contact persons for reference.

2) Installers shall certify that they are manufacturer-authorized or trained for work to be performed.

2. Project RCDD Requirements:
   a) Project RCDD shall be a current Registered Communications Distribution Designer as awarded by BICSI from time of bid through project’s substantial completion.
   b) Project RCDD shall be a full-time employee of the Telecommunications Subcontractor.

   1) Ensure the RCDD’s information is up-to-date on BICSI’s website. UT ITS will verify the Project’s RCDD status at the following website: [https://www.bicsi.org/forms/Verify/CredentialHolder/](https://www.bicsi.org/forms/Verify/CredentialHolder/)

   c) Submit copy of RCDD certificate with bid and pre-construction submittal package.

3. Lead Telecommunications Installer Requirements:
   a) Lead Communications Installer shall be a current member of BICSI in good standing and have completed (at a minimum) BICSI ITS Installer 2 Training (for both copper and fiber).
   b) Submit certificate of ITS Installer 2 Training (or higher) with bid and pre-construction submittal package.
   c) Advanced training from connectivity manufacturer may be submitted in lieu of BICSI ITS Installer 2 Training. Submit manufacturer training certificates for review by Owner as substitution request as part of Pre-Bid questions. This training must be by the same manufacturer that will hold the Advanced System Warranty.

4. General Telecommunications Installer Requirements:
   a) For all work associated with Specification Sections 270526, 270529, and 270553 through 271543, all installers are to have a minimum of BICSI ITS Installer 1 Training or equivalent training from the connectivity manufacturer.
   b) Submit a list with bid of names of all installers and appropriate copies of certificates verifying training with pre-construction submittal package.

5. Other Installer Requirements:
   a) Refer to individual sections for additional installer requirements for other systems within Division 27.

B. Audio/Video Subcontractor Qualifications

1. Refer to Section 27 40 00 for Audio/Video Subcontractor qualifications.
C. Warranty Requirements

1. Project Warranty
   a) Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect for a minimum of one year from date of project’s substantial completion.
   b) When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.

2. Advanced System Warranty for Telecommunications (Copper and Fiber Systems)
   a) Beyond the initial one year project warranty, the Copper and Fiber Telecommunications Systems shall be warrantied for a minimum of 15 years by a national and reputable connectivity or cabling manufacturer.
      1) This warranty shall to cover any material defect, as well as the performance of the cabling system. (Example: A Category 5e cabling system is to deliver 1000BASE-T speed, or 1 “Gig” performance for the entire length of the warranty period.)
      2) This warranty shall cover both material and labor for the full length of the warranty period.
   b) The Telecommunications Subcontractor shall be certified by this manufacturer.
   c) The following manufacturers are conditionally approved to provide the system warranties (subject to specific project requirements):
      1) Copper Connectivity Manufacturers
         (i) Ortronics
         (ii) Panduit
      2) Fiber Connectivity Manufacturers
         (i) Systimax
         (ii) Corning
      3) Cabling Manufacturers
         (i) Hitachi Cable Manchester
         (ii) Mohawk
         (iii) Superior Essex
         (iv) Or approved equivalent (Refer to section 1.8, B, 1.)

1.5 COORDINATION
A. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specifications or are
indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

B. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Telecommunications and Audio/Video Engineers. When abbreviations appear on the drawings or specifications in upper or lower case letters, with or without periods, the resultant work shall be as stated above.

C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.

D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.6 EXISTING CONDITIONS

A. Prior to bid, Telecommunications Subcontractor is to visit the existing building and evaluate all existing conditions. Bring to the attention of the Owner and Design Team any cause for concern or conflicts with the contract documents as soon as practically possible.

1.7 TRAINING

A. The appropriate Telecommunications and Audio/Video Subcontractor shall be responsible for training of facility personnel in accordance with requirements of this Section and Division.

B. Training shall take place within 2 weeks after substantial completion and shall include programs for on-site operations and maintenance of telecommunications and audio/video systems. Training shall be for not more than ten people, shall be held at the Owner's site in Austin, Texas, and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

1.8 SUBMITTALS

A. General Requirements

1. Provide Submittals in accordance with Division 1.

2. UT ITS Representative is to review and accept all submittals related to Division 27 work. This includes, but is not limited to, relevant:

   a) Pre-bid questions,

   b) Contractor and personnel qualifications with bid,

   c) Voluntary alternates and unit pricings with bid,
d) Pre-construction product submittals and shop drawings,
e) Change order requests, requests for information (RFIs), design change directives (DCDs), and any other changes as directed by the architect/engineer.
f) Record drawings and warranty certificates/letters.

3. Please allow a minimum of one week (five working days) for the ITS Representative to review (once delivered to ITS).

B. The following submittals are due at the Pre-Bid deadline for questions:

1. Requests for product substitution
   a) All products seeking approval either as “approved equivalent” or otherwise, shall be submitted as a product substitution request prior to bid. Failure to submit product substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to the Owner.
   b) The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in substitution request:
      1) Product being replaced
      2) Reason for product substitution
      3) Full manufacturer specification sheet clearly indicating that all requirements in project documents have been met.
   c) Failure to meet these requirements will result in the product substitution request being returned without review.
   d) All product substitution requests are to be reviewed and approved by the Owner (ITS Representative). Not all requests will be approved, and all decisions are final, without recourse.

C. The following submittals are due with the Bid:

1. Proof of Telecommunications Subcontractor and personnel qualifications.
   a) Provide a typed list with the following information:
      1) Company name of Telecommunications Subcontractor.
      2) List of connectivity or cabling manufacturers that the Telecommunications Subcontractor is certified to install and provide advanced warranty for.
      3) List of previous projects (minimum of 3) of this scope and nature, including:
         (i) Project name and date of completion
         (ii) Project size (square feet of building, total construction cost, total cost of telecommunications scope)
         (iii) Name and contact information for building owner or IT Manager.
4) Name and contact information for Project RCDD.

5) Name and contact information for Lead Telecommunications Installer, the de facto project manager on-site at all times. (This may be the same person as the Project RCDD.)

b) Provide certificates or letter(s) from BICSI and manufacturers verifying by name these qualifications have been met.

c) Refer to Quality Assurance subsection in this specification section for additional requirements and qualifications.

2. Proof of Audio/Video Subcontractor qualifications.

a) Provide a typed list with the following information:

1) Company name of Audio/Video Subcontractor

2) List of audio/video manufacturers Subcontractor is certified to install and program, as required by contract documents. (Example: Crestron, Electrovoice, etc.)

3) List of previous projects (minimum of 3) of this scope and nature, including:

   i) Project name and date of completion

   ii) Project size (square feet of building, total construction cost, total cost of telecommunications scope)

   iii) Name and contact information for building owner or IT Manager.

4) Name and contact information for Audio/Video Project Manager on-site at all times while audio/video equipment is being installed.

   i) Provide a list of previous projects for which this individual was the A/V Project Manager for.

   ii) Provide any certifications this individual has achieved, such as CTS-Installer, Crestron programming, etc.

3. Voluntary alternatives (that realize substantial cost savings)

4. Unit pricing for the following items:

a) Cost to add typical telecommunications work area outlet (with [two] cable drops) anywhere within the project/building footprint. This cost shall include electrical rough-in, cabling, faceplate, and modules at both ends for a complete and functioning outlet.

D. The following submittals are due at the Pre-Construction Phase [to be delivered to UT ITS Representative]:

1. General Requirements:

a) Follow submission guidelines as outlined in Division 1. At a minimum, provide the requirements as outlined in this section. Where Division 1 requirements are more stringent, follow those in addition to the requirements in this section.
1) Strictly electronic submission to UT ITS Representative is acceptable. General contractor, architect, and engineering requirements may differ.

b) Ensure a cover page with Project Title, Telecommunication or Audio/Video Subcontractor company, and point of contact are included for all physical submittals.

c) Updated Personnel Qualifications

   1) Provide a list of names of all telecommunications installers with appropriate certificates from BICSI or the manufacturer.

   2) Submit Quality Assurance certifications for the installers of the submitted Firestopping Systems. Refer to Section 27 05 37 for these requirements.

2. Product Information, divided by Specification Section and in order as listed in specification. Identify the start of each specification section.

   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.

      1) Submitted cutsheets without specific product identified will result in the whole submittal being returned without review.

      2) No product substitutions will be considered post bid without a significant cost savings to the project to be realized by the owner – a minimum of $1000, either in material or labor savings. For any product substitution requests post-bid, Telecommunications or Audio/Video Subcontractor shall submit an RFI through the proper channels with the requested documentation from the Pre-bid requirements above. Also, include realized cost savings. The project team may issue a change order (or its equivalent) for the product change at their discretion.

         (i) One exception to this is if the specified product goes out of production and is unavailable before submitted shop drawings are approved. Telecommunications or Audio/Video Subcontractor is to submit an RFI explaining the situation and recommending an equivalent product with the same features at no cost change to the project or Owner.

         (ii) Other exceptions may be considered. Telecommunications or Audio/Video Subcontractor is to submit an RFI explaining the situation.

   3) Specific product information to be included in submittal:

      (i) Cable Trays - Include documentation from manufacturer that the cable tray system has been UL-tested to be continuously grounded.

3. Shop Drawings

   a) Generate electronic shop drawings in AutoCAD, dwg file format, version 2004, 2007, or 2009, saved to disk (CD-R or DVD+/-R) or USB Flash Drive with project name and number clearly indicated [or uploaded to

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project website]. Shop drawings shall include Telecommunications or Audio/Video Subcontractor titleblock and included readily printable Plot/Drawing tabs with mview-window at a scale not to be less than 1/8”=1’-0” unless otherwise noted. The scale shall also be indicated on the drawings.

1) Acceptable electronic shop drawing sizes include: 8.5”x11”, 11”x17”, 22”x34”, 24”x36” or 36”x48”.

2) It is permissible to incorporate multiple specification section requirements on a series of shop drawings, such as Hangers & Supports, Conduits & Backboxes, Cable Tray, Firestopping, Identification, and Copper Horizontal Cabling locations.

b) Refer to individual sections for additional requirements.

c) Grounding and Bonding Shop Drawings

1) Indicate fully-coordinated location and size/length of TMGB, TGBs, BCT and TBB conductors, and all splice points. (It is acceptable to incorporate grounding information on shop drawings with other Division 27 information, such as cable tray routing.)

2) Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4” = 1’-0”) indicating fully-coordinated locations of TMGB and TGBs.

d) Communications pathways

1) Hangers and Supports – indicate proposed routing of all cabling supported by j-hooks.

2) Conduits and Backboxes – indicate proposed locations of communications outlets, conduits (including size), pullboxes (including size) and conduit sleeves (including size); should any of those locations or sizes differ from the construction drawings due to minor coordination issues, cloud the affected area and note why the change is necessary. (For major coordination issues, please submit an RFI.)

3) Cable Trays - indicate size and proposed routing of all communications cable trays; should any of those locations or sizes differ from the construction drawings due to minor coordination issues, cloud the affected area and note why the change is necessary. (For major coordination issues, please submit an RFI.)

4) Firestopping – indicate manufacturer, product/assembly, and UL system for all firestop penetrations required for communications cabling.

5) Example:
E. The following submittals are due during Construction (project closeout), in accordance with the submittal requirements in Section 27 00 00 Communications:

1. 3 weeks prior to Substantial Completion:
   a) Record Drawings
      1) Modify reviewed and accepted AutoCAD shop drawings to include revisions based upon completion of work.
      2) Provide (1) printed set of record drawings to scale (not less than 1/8” = 1’-0”).
         (i) For Telecommunications T-sheets, the Project RCDD is to include their RCDD stamp on the drawings and provide a letter stating their portion of the project was installed to construction documents and referenced codes, standards and guidelines.
      3) This set is to include system function diagrams and details not on original construction documents.
   b) Connection and programming schedules, as appropriate. (Microsoft Excel 2007 or cvs format)
   c) Equipment material list, including quantities. (Microsoft Excel 2007 or cvs format)
d) Test Results, in accordance with section 27 05 26 Grounding and Bonding for Communications Systems, 27 08 10 Optical Fiber Testing, and 27 08 20 Copper Testing.

e) Operation and Maintenance Manuals for all installed equipment (in accordance with Division 1)

1) The manual shall be subdivided into separate specification sections with folders to identify subsystems of the integrated system.

2) The manual will include Manufacturers’ description literature (specification or cutsheet) for installed equipment.

3) Provide the following additional information for each electronic system.

   (i) Operations manuals for components and for system as a whole.

   (ii) Maintenance manuals for components and for system as a whole.

   (iii) List of spare parts (provide quantities), materials and suppliers of components. Provide name, address and telephone number for each supplier.

   (iv) Emergency instructions for operational and maintenance requirements.

   (v) Delivery time frame for replacement of component parts from suppliers.

   (vi) Troubleshooting procedures for each system and for each major system component.

f) With the exception of the (1) printed set of record drawings, submit these files electronically either on disk (CD-R or DVD+/−R) or USB Flash Drive, with project name and number clearly indicated.

2. Within two weeks after Substantial Completion:

a) Training for all Division 27 Systems

b) Warranty Certificates for the Advanced Telecommunications System Warranty for the copper and fiber systems with point of contact for any warranty claims.

PART 2 – PRODUCTS

2.1 GENERAL

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.

C. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.
PART 3 - EXECUTION

3.1 PROJECT RCDD

A. At a minimum, Project RCDD shall perform weekly inspections during construction to ensure Division 27 installation meets the requirements and recommendations in the referenced codes, standards, and guidelines.

1. The Project RCDD shall invite the Design Engineer and ITS Representative to these weekly inspections.

2. Should any disparity be discovered by the Project RCDD, Design Engineer, or ITS Representative, contractor shall make necessary corrections without cost or time change to the project.

3.2 GENERAL

A. Coordinate with all other trades prior to installation.

1. Telecommunications and Audio/Video Subcontractors shall meet with Electrical and General Contractors prior to construction to identify pathway and infrastructure space requirements.

   a) At a minimum, the following items shall be discussed:

      1) Cable tray locations and clearance space above (12” if possible, with proper coordination)

      2) In-ceiling projection screens and other audio/video equipment.

   b) Failure to coordinate sufficient space for telecommunications and audio/video infrastructure shall result in relocation of various systems by the contractor at no additional cost to owner.

2. Prior to the start of work, the Telecommunications and Audio/Video Subcontractors shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.

3. Coordinate location of equipment and conduit with other trades to minimize interference.

   a) Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Design Engineer as required by limited working space.

   b) Holes shall be located so as not to affect structural sections such as ribs or beams.

   c) Holes shall be laid out in advance. The Design Engineer shall be advised prior to drilling through structural sections, for determination of proper layout.

   d) Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.
B. Follow all manufacturers’ instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
   1. In the event of discrepancy, immediately notify the Design Engineer through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

C. Protection of Systems and Equipment
   1. Asbestos Survey: Prior to the disturbance of any building materials, construction personnel must know the results of an asbestos survey.
   2. Lead Survey: Prior to the disturbance of any building materials, construction personnel must know the results of a lead survey.
   3. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
   4. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.
   5. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
   6. As determined by the Design Engineer, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Design Engineer shall be final.
   7. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
   8. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

D. Access to Equipment
   1. Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.
   2. Working spaces shall be not less than specified in the National Electrical Code for voltages specified.
   3. Where the Design Engineer determines that the Telecommunications Subcontractor has installed equipment not “conveniently accessible” for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Design Engineer, at no additional cost to the Owner.

E. Cleaning
   1. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying elements prior to being energized.

F. Completion
1. General:
   a) Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

2. Results Expected:
   a) Systems shall be complete and operational and controls shall be set and calibrated.
   b) Testing, start-up and cleaning work shall be complete.
   c) Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3. Testing and Verification – General Requirements
   a) Refer to individual sections for additional testing and verification requirements.
   b) The Telecommunications Subcontractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
   c) Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.
   d) Verification by Test and Demonstration: The Telecommunications and Audio/Video Subcontractors shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Communications Subcontractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test". Even though no formal environmental testing is required, the communications Subcontractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test".
   e) Perform commissioning and pretest prior to enclosure of walls.
   f) Perform system operation tests after full enclosure of walls.
   g) System Operation Tests Conducted Upon Completion of Work: Upon completion of the Telecommunications and Audio/Video Subcontractor's Work, subject the system to functional and operational tests. When required, corrections determined by initial test results, have been
completed, fully retest the system. The Owner shall be notified in writing not less than seven days in advance of date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable and that the Telecommunications and Audio/Video Subcontractor has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection shall be accomplished in the presence of the Owner and the Design Engineer. At least 10 days prior to scheduled system completion, the Telecommunications and Audio/Video Subcontractors shall submit, for approval by Owner and DESIGN ENGINEER, a test plan to completely test the telecommunications and audio/video systems. The Telecommunications and Audio/Video Subcontractors shall include in test plan, for acceptance by the Owner and Design Engineer, a complete and detailed final acceptance test check-off list ("punch list"). The list shall be a complete representation of specified functions and conditions, including contingency, priority and abnormal modes of operation. The arrangement of the list shall be such as to provide an orderly method of tabulating checks of system features, response and operation. The punch list shall include a designated space adjacent to each test procedure where the Design Engineer can mark his initials to indicate compliance with each test procedure. The Owner and Design Engineer may add items to this check-off list prior to Subcontractors' commencement of System Operation Tests. At the time of final acceptance testing, required tests shall be repeated and defects corrected until the system is found to be acceptable to the Owner and the Design Engineer. The Telecommunications Subcontractor shall maintain a log of test activities and results. Both electronic and printed copies of this log including copies of the signed-off punch list shall be submitted to the Owner within seven days of the testing.

4. **Commissioning**
   a) Commissioning of the communications systems (telecommunications and audio/video) is to be completed by the Design Engineer for each system.
   b) There shall be three phases of commissioning:
      1) Rough-in inspection
      2) Above-ceiling inspection (after cables are placed)
      3) Final inspection
   c) Once electrical rough-in and pathways have been installed, but prior to walls and ceilings being installed, contractor shall request of the design team, in writing, for the official rough-in inspection to take place. The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the ITS Representative to attend this inspection. If the ITS Representative is unavailable at that time, they may request another ITS employee attend in their place.
      1) At a minimum, the Design Engineer shall check the following items:
(i) Accurate location and height above finished floor for all outlet boxes.
(ii) Accurate dimensions (particularly depth) of all outlet boxes and diameter of in-wall conduit serving outlet boxes.
(iii) Cable tray size, location, and clearance.
(iv) Location and size of all other communications conduits or pathways.
(v) That power receptacles within the communications rooms meet the design requirements.

2) The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate communications subcontractor and all items are to be addressed. This report is not necessarily all-inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.

d) Once all communication cabling has been installed and properly supported and walls have been painted, but prior to the installation of ceiling tiles/material, contractor shall request of the design team, in writing, for the official above-ceiling inspection. The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the ITS Representative to attend this inspection. If the ITS Representative is unavailable at that time, they may request another ITS employee attend in their place.

1) At a minimum, the Design Engineer shall check the following items:
   (i) That all items from the previous inspection have been corrected.
   (ii) That communications cabling is routed correctly and adequately supported.
   (iii) That communications cabling is not painted or oversprayed.
   (iv) That the installed communications cabling matches what was specified/submitted.
   (v) That there are no kinks, splices, or other damage to the installed communications cabling.

2) The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate communications subcontractor and all items are to be addressed. This report is not necessarily all-inclusive; should issues be discovered later in the project, the
appropriate communications subcontractor is still responsible for corrections/repairs.

e) Once all communications work has been completed, contractor shall request of the design team, in writing, for the official final inspection. *This request shall be made 3 weeks before substantial completion.* The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the ITS Representative to attend this inspection. If the ITS Representative is unavailable at that time, they may request another ITS employee attend in their place.

1) At a minimum, the Design Engineer shall check the following items:

   (i) That all items from the previous inspections have been corrected.

   (ii) That all faceplates are installed, with the correct modules, quantity of modules, and approved labeling scheme.

   (iii) That all equipment and cabling within communications rooms is installed per the contract documents, including all patch panels and wall blocks (with specified spare capacity), horizontal and backbone cabling labeling, and telecommunications grounding.

   (iv) And all other items necessary to guarantee contract documents are met and complete and functioning communications systems are installed.

2) The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate communications subcontractor and all items are to be addressed prior to substantial completion. This report is not necessarily all-inclusive; should issues be discovered within one year after substantial completion, the appropriate communications subcontractor is still responsible for corrections/repairs.

END OF SECTION
SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY
A. This section governs the products and execution requirements relating to furnishing and installing grounding and bonding for the communication systems.
B. Description of work:
   1. Furnish and install a complete and fully-functioning grounding and bonding system. All cables, terminations, support hardware, and grounding and bonding hardware shall be furnished, installed, tested, labeled, and documented by the telecommunications subcontractor.
      a) Coordinate with electrical contractor including pathways, termination points, busbar locations and connections to the main electrical service ground and electrical distribution panels.

1.2 RELATED DOCUMENTS
A. The most recent versions of all related documents apply to this project.
B. The following codes shall be followed as required by law:
   1. National Electric Code (NEC)
C. The following standards shall be followed:
   1. IEEE Std 1100 - IEEE Recommended Practice for Powering and Grounding Electronic Equipment (Emerald Book)
   2. ANSI/NECA/BICSI--607 - Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
   3. ANSI/TIA--607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
D. The following guidelines shall be followed:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
E. The following related project specifications shall be followed:
   1. 27 00 00 Communications
   2. 27 05 53 Identification for Communications Systems

1.3 DEFINITIONS AND ACRONYMS
A. BCT – Bonding Conductor for Telecommunications -- A conductor that interconnects the telecommunications bonding infrastructure to the building’s service equipment (power) ground.
B. Bonding – The joining of metallic parts to form an electrically conductive path.
C. GE – Grounding Equilizer -- The conductor that interconnects elements of the telecommunications grounding infrastructure.

D. Ground – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g., telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

E. NRTL – Nationally Recognized Testing Laboratory

F. RBC – Rack Bonding Conductor -- A bonding conductor used to connect an equipment rack directly to the TMGB, or TGB.

G. RGB – Rack Grounding Busbar -- A busbar that is vertically mounted on an equipment rack.

H. TBB – Telecommunications Bonding Backbone -- A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar.

I. TGB – Telecommunications Grounding Busbar -- A common point of connection for telecommunications system and equipment bonding to ground, and located in the telecommunications room or equipment room.

J. TMGB – Telecommunications Main Grounding Busbar -- A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

K. UBC – Unit Bonding Conductor -- A conductor that interconnects the Rack Bonding Busbar to the telecommunications equipment.

1.4 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:

1. Product Information
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified.

2. Shop Drawings
   a) Provide scaled drawings (floor plans not less than 1/16” = 1’-0”) indicating the location and size, dimensions, type of connection (e.g., mechanical, exothermic weld of each bonding busbar (e.g., TMGB, TGB), conductor (e.g., BCT, GE, TBB), connections (e.g., lugs), and splice points.
   b) Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4” = 1’-0”) indicating locations of busbars (e.g., TMGB, TGB, UBC, RGB).
   c) Bonding and Grounding shall have its own separate drawing(s).

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:

1. Record Drawings
Grounding and Bonding for Communications

The University of Texas at Austin  
September 30, 2011

a) Provide scaled drawings (floor plans not less than 1/16" = 1'-0") indicating actual location and size/length of TMGB, TGBs, BCT, GE and TBB conductors and all splice points.

b) Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4" = 1'-0") indicating actual locations of TMGB and TGBs.

c) Bonding and Grounding shall have its own separate drawing(s).

2. Manufacturer and Maintenance Manuals for all installed equipment. This is to include:

a) Manufacturer specification sheets (cutsheets) and installation instructions/manuals for all installed products.

3. A letter from the contractor Project RCDD stating that the grounding system has been installed in accordance with the project documents and the referenced codes, standards, and guidelines. This letter is to also specifically acknowledge that the telecommunications grounding system has been fully tested according to these specifications. The required contents of this letter may be incorporated into the letter required from the Project RCDD in section 27 00 00.

PART 2 – PRODUCTS

2.1 GENERAL

A. All components shall be Listed by a NRTL.

2.2 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

A. A telecommunications main grounding busbar (TMGB) shall be provided and installed at the telecommunications service entrance (or as indicated on the drawings).

B. The TMGB shall:

1. Be a predrilled copper busbar with holes for use with correctly matched Listed lugs and hardware.

2. Have minimum dimensions of 0.25” thick by 4” wide by 16” long. Increase length as necessary to provide all connections plus 25% spare capacity.

3. Be Listed aby a NRTL.

4. Be manufactured by:

   a) Chatsworth
   b) Erico
   c) Harger
   d) Hoffman
   e) Panduit
   f) Or approved equivalent

2.3 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

A. A telecommunications grounding busbar (TGB) shall be provided and installed in each telecommunications room.
B. The TGB shall:
   1. Be a predrilled copper busbar with holes for use with correctly matched Listed lugs and hardware.
   2. Have minimum dimensions of 0.25" thick by 2" wide by 12" long. Increase length as necessary to provide all connections plus 25% spare capacity.
   3. Be listed by a NRTL.
   4. Be manufactured by:
      a) Chatsworth
      b) Erico
      c) Harger
      d) Hoffman
      e) Panduit
      f) Or approved equivalent

2.4 BONDING CONDUCTOR FOR TELECOMMUNICATIONS (BCT)
A. A BCT shall:
   1. be copper and may be insulated.
   2. be Listed for the application when insulated.
   3. As a minimum, the same size as the largest TBB.

B. The manufacturer shall be:
   1. Harger
   2. Or approved equivalent

2.5 TELECOMMUNICATIONS BONDING BUSBAR (TBB)
A. The TBB shall:
   1. be copper and may be insulated.
   2. be Listed for the application when insulated.
   3. Be sized at 2 kcmil per linear foot of conductor length up to a maximum size of No. 3/0 AWG.

2.6 GROUNDING EQUILIZER (GE)
A. A GE shall:
   1. be copper and may be insulated.
   2. be Listed for the application when insulated.
   3. As a minimum, the same size as the largest TBB.

B. The manufacturer shall be:
   1. Harger
   2. Or approved equivalent

2.7 RACK BONDING CONDUCTOR (RBC)
2.8 RACK GROUNDING BUSBAR (RGB)
A. Description: grounding Strip for 2-post and 4-post Communications Racks.
B. A RGB shall:
   1. be wrought copper and tin plated.
   2. be capable of supporting multiple unit bonding conductors.
   3. be Listed.
C. The manufacturer shall be:
   1. Harger
   2. Panduit, Grounding Strip Kit, RGS134-1Y
   3. Or approved equivalent

2.9 GENERAL BONDING CONDUCTORS OR JUMPERS
A. Provide and install general bonding conductors and jumpers per construction documents. Refer to drawings and execution section for required locations.
B. For all conductors and jumpers connecting equipment located in the same room as the TMGB/TGB, conductors/jumpers shall be in a green insulated jacket. This jacket shall include markings that indicate conductor size (minimum of #6 AWG), manufacturer, and UL listing.
C. Manufacturer shall be:
   1. Harger
   2. Panduit
   3. Or approved equivalent

2.10 BONDING ACCESSORIES
A. Grounding Lugs
   1. Shall be Listed for the application.
   2. Shall be two holes compression crimp with inspection window, unless otherwise noted.
   3. Copper or tin plated copper.
   3. Manufacturers shall be:
      a) Erico, Cadweld Telecom Lugs
      b) Harger
c) Panduit  
d) Or approved equivalent

B. Unit Bonding Conductor (UBC)
1. Shall be Listed for the application.
2. Shall be a minimum No. 12 AWG  
2. Copper with 90-degree bent lugs installed.
3. Manufacturers shall be:
   a) Erico, Cadweld Telecom Lugs  
b) Harger  
c) Panduit  
d) Or approved equivalent

PART 3 - EXECUTION

3.1 GENERAL
A. Locate TMGB and TGBs so that they are accessible to telecommunications personnel.
B. At a minimum, follow all manufacturer instructions. In case of discrepancy between manufacturer and contractor requirements, the more stringent shall apply. In the case of conflicting instructions, report any discrepancy to the Design Engineer in a timely fashion so as not to impact the construction timeline.
C. At a minimum, provide exothermic welds as identified on the drawings or required in the specifications. For all other connections, irreversible compression connections are sufficient.
D. Identification
1. All telecommunications grounding and bonding conductors shall be labeled within 6" of each end. Labels shall be nonmetallic and read as follows:

   IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER

E. Testing
1. All grounding connections shall be tested for continuity and resistance after installation but prior to substantial completion. The telecommunications contractor is to invite the Design Engineer and ITS representative to witness a portion of this testing while it is being performed.
2. The test performed shall use an earth ground resistance tester that is configured for a continuity test otherwise known as a two-point test or a “dead earth” test. Tests shall be conducted between the electrical entrance ground and the TMGB as well as at each TGB. This resistance shall be less than 0.05 Ohms.
3.2 TMGB
A. All metallic raceways for telecommunications cabling located within the same room or space as the TMGB shall be bonded to the TMGB.
B. Insulate the TMGB 2" from the wall.
C. For outside plant cables entering a building with a cable shield isolation gap, bond the cable shield (on the building side of the gap) to the TMGB. Outside plant protectors shall be bonded to the TMGB with a No. 6 AWG conductor.
D. Connections to the busbar shall be made with 2-hole lugs.
E. Connections shall be made by cleaning the area of connection on the busbar and on the two-hole lug and then applying a thin coating of anti-oxidant compound.

3.3 TGB
A. All metallic raceways for telecommunications cabling located within the same room or space as the TGB shall be bonded to the TGB.
B. Insulate the TGB 2" from the wall.
C. Connections to the busbar shall be made with 2-hole lugs.
D. Connections shall be made by cleaning the area of connection on the busbar and on the two-hole lug and then applying a thin coating of anti-oxidant compound.

3.4 BCT
A. Route BCT in conduit from telecommunications service entrance room to the main electrical service ground connection.

1. Label conduit at telecommunications service entrance with tag or adhesive label that states “Building Conductor for Telecommunications (BCT) to Main Electrical Service Ground Connection”.

2. Label conduit at main electrical service ground connection with tag or adhesive label that states “Building Conductor for Telecommunications (BCT) to Telecommunications Main Grounding Busbar (TMGB)”.

3. BCT shall not be run in a metallic conduit and shall not be completely encircled by metallic clamps.

3.5 TBB
A. Where following the same routing as cable tray, attach TBB on the outer side of the cable tray to minimize contact with communications cabling.

B. Size the TBB according to the following cable:

<table>
<thead>
<tr>
<th>Sizing of the TBB</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TBB Length in Linear meters (feet)</td>
<td>TBB Size AWG</td>
</tr>
<tr>
<td>Less than 4 (13)</td>
<td>6 (16mm²)</td>
</tr>
<tr>
<td>4-6 (14-20)</td>
<td>4 (25mm²)</td>
</tr>
<tr>
<td>6-8 (21-26)</td>
<td>3 (25mm²)</td>
</tr>
<tr>
<td>8-10 (27-33)</td>
<td>2 (35mm²)</td>
</tr>
<tr>
<td>10-13 (34-41)</td>
<td>1 (35mm²)</td>
</tr>
<tr>
<td>13-16 (42-52)</td>
<td>1/0 (50mm²)</td>
</tr>
<tr>
<td>16-20 (53-66)</td>
<td>2/0 (70mm²)</td>
</tr>
<tr>
<td>Greater than 20 (66)</td>
<td>3/0 (95mm²)</td>
</tr>
</tbody>
</table>
3.6 GENERAL BONDING CONDUCTORS OR JUMPERS
A. General bonding conductors or jumpers are to be utilized in each telecommunications room between the TMGB/TGB and the following components:
1. The communications building entrance protectors.
2. Electrical panel board (if in same room as TMGB/TGB).
3. Building steel (if available in same room as TMGB/TGB).
4. Telecommunications ladder rack and cable tray.
   a) Bonding jumpers may be utilized to ground adjacent pieces of ladder rack and cable tray together, reducing the need to a single conductor back to the TMGB/TGB.
   b) In cases where ladder rack or cable tray is painted, it is assumed that the paint will need to be removed at the connection point to ensure a completely bonded connection. If this is not the case, submit documentation from manufacturer indicating NRTL testing was done in regards to grounding without removal of the paint.
5. Telecommunications equipment racks and cabinets.
   a) Each cabinet and rack shall be bonded to the TMGB/TGB directly with a #6 AWG RBC from the Rack Grounding Busbar (RGB).
   b) In cases where equipment racks or cabinets are painted, it is assumed that the paint will need to be removed at the connection point of the RGB to ensure a completely bonded connection. If this is not the case, submit documentation from manufacturer indicating NRTL testing was done in regards to grounding without removal of the paint.

3.7 GROUNDING LUGS
A. Wires shall be inserted to the full depth of the lug.
B. Space between wire insulation and the body of the compression lug shall be kept to a maximum of 1/4 inch.
C. Lug must agree with wire size.
D. To assure proper die is used with the specified connector, manufacturer's embossed coding systems shall be adhered to.
E. Connectors shall not be modified in any way.
F. Daisy chaining and stacking (piggy backing) of ground lugs is prohibited.
G. Bolts, nuts, washers used to secure ground connections shall match the diameter of the hole.

END OF SECTION
SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of hangers and supports for communications systems.

1.2 RELATED DOCUMENTS

A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.

B. The following codes, as required by law:
   1. National Electric Code (NEC)

C. The following standards:
   1. TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces
   2. NECA/BICSI 568-2006, Installing Commercial Building Telecommunications Cabling

D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Product Information
      a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
   2. Shop Drawings
      a) In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8” = 1'-0”) indicating routing of cable and means of support (where supported by cable tray vs. j-hooks). These locations are to be fully coordinated with all other trades.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
   1. Record Drawings
      a) In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8” = 1'-0”) indicating routing of cable and means of support. Design drawings or shop drawings modified in the field will not be accepted.
   2. Manufacturer and Maintenance Manuals for all installed equipment.
a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.

PART 2 – PRODUCTS

2.1 CABLE HOOKS (J-HOOKS)

A. Cable hooks shall:
   1. Be listed by a NRTL for installation into a plenum space.
   2. Be specifically designed for telecommunications cables.
   3. Bear a surface of sufficient width to comply with required bend radii of high-performance cables;
   4. Have flared edges to prevent damage while installing cables.
   5. Include a top latch to keep cable within the hook. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

B. Cable support sling shall:
   1. Be constructed from steel and woven laminate
   2. Have a static load limit of 100 lbs.

C. Manufacturer shall be:
   1. Cooper B-Line, BCH Series
   2. Erico, Cablecat Series
   3. Panduit, J-Pro Series
   4. Or approved equivalent

PART 3 - EXECUTION

3.1 GENERAL

A. Follow all manufacturers’ instructions.
B. Coordinate with all other trades prior to installation.
C. All telecommunications cabling not routed through conduit or cable tray shall be supported every 60” or less.
D. Telecommunications cables shall not be supported by any other trades, and shall be fully-supported by independent methods.

3.2 CABLE HOOKS (J-HOOKS)

A. Cable hooks, shall not be supported by ceiling grid support wires.
B. Where support wires are used, independent support wires shall be attached to the structural ceiling (above floor deck) on one end and to the suspended ceiling grid on the other end. The prior is meant to carry the load, the latter is meant to act as a "sway control".
C. Size cable hooks to allow for a maximum of 25% capacity to facilitate future installation of cables.
D. Cable hooks shall be installed such that cable slack between supports is a minimum of 6” above ceilings.

E. Provide adequate cable hooks to ensure telecommunications cabling is a minimum of 6” from light fixtures and power conduits.

F. Where telecommunications cabling is being supported with cable hooks, provide a cable hook at every change in direction.

G. Cable hooks shall be installed in a conveniently accessible location. (Refer to definition in Section 27 00 00.)

H. Route cabling such that a minimum of 48” is provided between cabling and electric motors or generators.

END OF SECTION
SECTION 27 05 33
CONDUITS AND BACKBOXES FOR COMMUNICATIONS

PART 1 – GENERAL

1.1 SUMMARY
A. This section governs the products and installation of conduits, backboxes, and additional accessories, connections, fittings, and equipment required for in-building communications systems, otherwise known as “Electrical Rough-In”.

1.2 RELATED DOCUMENTS
A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.
B. The following codes, as required by law:
   1. National Electric Code (NEC)
C. The following standards:
   1. TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
   2. NECA/BICSI-568-2006, Standard for Installing Commercial Building Telecommunications Cabling
D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
E. The following project specifications:
   1. 27 05 26 Grounding and Bonding for Communications
   2. 27 05 53 Identification for Communications Systems

1.3 DEFINITIONS AND ACRONYMS
A. Conveniently Accessible - being capable of being reached from floor or use of 8’ step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.
B. IMC – Intermediate Metal Conduit
C. Listed Communications Cable – A cable Listed by a Nationally Recognized Testing Laboratory (NRTL) and acceptable to the local authority having jurisdiction (AHJ) as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to NEC Articles 725, 770 and 800 for listing types and additional requirements. **Assume Outside Plant (OSP) Cables being supplied to the building by ITS are not Listed.**
D. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
E. Plenum-rated – A product that is Listed by a NRTL as being suitable for installation into a plenum space. Communications cabling shall be Listed and identified as type CMP.
F. Point of Entrance (Building Entrance): The point within a building at which the Outside Plant (OSP) communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the NEC.

G. RMC – Rigid Metal Conduit

H. UL – Underwriters Laboratory

1.4 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:

1. Product Information
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.

2. Shop Drawings
   a) Provide scaled drawings (not less than 1/8” = 1’-0”) indicating routing of conduits and locations of all pull points (to include pullboxes, communications LB, etc.). These locations are to be fully coordinated with all other trades.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:

1. Record Drawings
   a) Provide scaled drawings (not less than 1/8” = 1’-0”) indicating actual installed routing of conduits and locations of all pull points. Design or shop drawings modified in the field will not be accepted.

2. Manufacturer and Maintenance Manuals for all installed equipment

3. Keys for any pullboxes (if applicable)

PART 2 – PRODUCTS

2.1 GENERAL

A. Refer to Electrical specifications for additional information.

2.2 CONDUIT

A. Refer to execution section for sizing and installation requirements.

B. Refer to Electrical specifications for list of approved manufacturers.

2.3 BACKBOXES

A. Typical communications backbox shall have the following minimum dimensions:
   4-11/16” x 4-11/16” x 2-1/2”

   1. Refer to drawings for plaster ring size/opening

   2. For outlets in stud wall, Manufacturer shall be:

      a) RACO 259 with a minimum of 3/8” deep raised cover or plaster ring

      b) Randl T-55017 with appropriate extension or plaster ring
c) Or approved equivalent

3. For outlets in CMU wall, submit appropriate backbox for application.

2.4 PULLBOXES

A. Material shall be aluminum or steel.

B. The following manufacturers are conditionally-approved:
   1. Hoffman
   2. Or approved equivalent

C. Refer to execution section for sizing and installation requirements.

2.5 ELEVATOR DEMARC(ATION) BOX

A. In each elevator machine room, the Elevator Contractor is to provide an 18” x 24” x 6” deep hinged lockable Junction Box.

   1. Provide 2” conduit back to serving Communications Room. Confirm location of Demarcation Box with Elevator Contractor prior to installation.

      a) Label conduit at both ends and pullboxes between Elevator Equipment Room and Communications Room as “ITS ELEVATOR”.

      b) This conduit is to be used for all voice, data, and security circuits.

PART 3 - EXECUTION

3.1 GENERAL

A. Follow all manufacturers’ instructions.

B. Coordinate with all other trades prior to installation.

C. The contractor’s Project RCDD shall perform weekly inspections during construction to verify the conduits, backboxes, and other electrical rough-in meet these specifications and referenced documents. Each week of rough-in installation, the contractor’s Project RCDD shall invite the Design Engineer and ITS Representative to weekly inspections.

   1. Should any disparity between construction and these specifications be discovered by the contractor’s Project RCDD, Design Engineer, or ITS Representative at any point during the course of construction, contractor shall make necessary corrections without cost or schedule change to the project.

3.2 CONDUIT

A. Conduit size to telecommunications outlet shall be trade size 1-1/4” UON.

B. Conduits which enter Communications Entrance Facilities shall extend:
   1. 4” AFF, or;
   2. 3” below finished ceiling.
   3. 3” through wall.

C. Conduits shall be reamed and bushed.

D. Communications Building Entrance Conduits entering a building shall be RMC or IMC construction, and shall extend to within 50’ cable length from the wall reserved for Building Entrance Protection in the Communications Entrance Facility.

E. Minimum Bend Radius
1. For trade size conduits 2” or less, maintain a minimum bend radius of (6) times the actual inside diameter of the conduit.

2. For trade conduits greater than 2”, maintain a minimum bend radius of (10) times the actual inside diameter of the conduit.

F. No continuous section of conduit may exceed 100 feet. Utilize pullboxes as necessary.

G. No continuous section of conduit may include more than (2) 90 degree bends (or equivalent).
   1. An offset is considered a 90 degree bend.
   2. A pullbox is required wherever a reverse (180 degree) bend is installed.

H. Conduit to Floor Boxes in Slab-on-Grade
   1. Slab-on-grade conduits shall not be installed.

I. Flexible Conduit
   1. As defined by the NEC.
   2. To be utilized only at specific locations identified on the drawings.
   3. Sections are to be limited to a maximum of 20 feet in length and the trade size shall be increased by one.

3.3 BACKBOXES

A. Backboxes installed into fire-rated walls shall include appropriate firestopping system (See Division 7).

B. Where back-to-back with outlet on opposite side of wall, off-set one of the backboxes and conduits to adjacent stud cavity or masonry block.

3.4 PULLBOXES

A. Directional changes within a pullbox shall not be allowed. Refer to the following diagrams:

   ![Diagram of pullbox usage]

B. Size pullboxes according to the following chart:

<table>
<thead>
<tr>
<th>Conduit Trade Size</th>
<th>Width Increase for Additional Conduit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>2”</td>
</tr>
<tr>
<td>1-1/4”</td>
<td>3”</td>
</tr>
<tr>
<td>1-1/2”</td>
<td>4”</td>
</tr>
<tr>
<td>2”</td>
<td>5”</td>
</tr>
<tr>
<td>2-1/2”</td>
<td>6”</td>
</tr>
</tbody>
</table>
C. Install pullboxes in conveniently accessible locations.
D. Where identified on drawings as lockable, key all pullboxes the same.
E. Identify pullboxes according to Section 27 05 53.

END OF SECTION
SECTION 27 05 36
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This section shall govern the products and installation of all necessary parts, pieces and accessories of a cable tray system for communications and other low-voltage cabling.

1.2 RELATED DOCUMENTS
A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.
B. The following codes, as required by law:
   1. National Electric Code (NEC)
C. The following standards:
   1. ASTM A 510 - Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
   3. ASTM A653 - Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process
   5. ASTM A276-06 - Standard Specification for Stainless Steel Bars and Shapes
   6. ASTM A580/A580M-06 Standard Specification for Stainless Steel Wire
   7. NECA/BICSI-568-2006, Standard for Installing Commercial Building Telecommunications Cabling
   8. TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
   9. ANSI/TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
   3. NEMA-VE2, Metal Cable Tray Installation Guidelines
   4. NFPA 70B, Recommended Practice for Electrical Equipment Maintenance

1.3 QUALITY ASSURANCE:
A. All cable trays, including all parts, pieces and connections, shall be certified from a NRTL for the intended purpose.

1.4 SUBMITTALS
A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:

1. Product Information
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
   b) Include documentation from manufacturer that the cable tray system has been UL-tested to be continuously grounded.
   c) Where the desired distance between cable tray supports is greater than 5’, provide calculations indicating maximum distance given the worst-case load factor (for the area with the greatest density of cables).

2. Shop Drawings
   a) In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8” = 1’-0”) indicating routing of cable and means of support (where supported by cable tray vs. j-hooks). These locations are to be fully coordinated with all other trades.
   b) Where submitted locations of cable trays differ from those in the contract documents, note the shop drawings with the reason for the relocation.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:

1. Record Drawings
   a) In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8” = 1’-0”) indicating routing of cable and means of support. Design drawings or shop drawings modified in the field will not be accepted.

2. Manufacturer and Maintenance Manuals for all installed equipment.
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
   b) List of bill of materials, including all parts, pieces and connectors required for installation of the cable tray system.

PART 2 – PRODUCTS

2.1 GENERAL
   A. The cable tray system shall be Listed for its location and intended purpose.
   B. The cable tray system shall be Listed to allow for continuous grounding. Refer to execution section for additional grounding requirements.

2.2 CABLE TRAY (WIRE MESH)
   A. Shall be an approximately 2” x 4” grid construction welded wire linear mesh.
   B. Finish shall be: Electro-Zinc or Hot Dipped Galvanized (UON)
   C. Manufacturer shall be:
      1. Cablofil, CF Series
      2. Chatsworth OnTrac Series
3. Snake Tray, Mega Snake  
4. Or approved equivalent

2.3 RIGID CABLE TRAY
A. To be utilized only where specifically called out on the drawings.  
   1. For excessively high structures, rigid cable tray may be utilized to minimize the number of ceiling supports. Submit question during bid-window or as a construction RFI requesting use of rigid cable tray. Rigid cable tray may not be utilized without express written permission from the Owner.

B. Material shall be aluminum or steel.

C. All bends, intersections, and changes in direction shall be modular (pre-manufactured). Field modifications are not acceptable.

D. Manufacturer shall be:
   1. Cablofil, PW
   2. Or submit equivalent

2.4 CABLE TRAY (SPECIAL APPLICATION)
A. G-shaped Cable Tray  
   1. For areas where specifically identified on the drawings. For other areas, submit question during bid-window or as a construction RFI requesting use of G-shaped cable tray.

   2. Manufacturer shall be:  
      a) Cablofil, CFG and G-MINI Series  
      b) Snake Tray, Series 201  
      c) Or approved equivalent

PART 3 - EXECUTION
3.1 GENERAL
A. Minimum clearances for cable tray:
   1. Maintain as much separation from EMI sources as practical. At a minimum, cable tray shall be installed at least:
      a) 6” away from fluorescent light fixtures  
      b) 6” away from power lines (circuits) enclosed in a grounded metal conduit  
      c) 48” away from electrical motors and transformers

   2. Install a minimum of 3” above accessible ceiling T-bars and 6” if the space exists.

   3. Install with 12” headroom above cable tray (where space exists).  
      a) Coordination with other trades is imperative. It is the telecommunications sub-contractor and the general contractor’s responsibility to ensure all ductwork, piping, etc. of other trades is installed to allow successful installation of cable tray. The final location
of cable tray shall allow future cables to be easily installed; cables shall not have to be pulled through cable tray due to the top being inaccessible.

b) Where overhead space is restricted, consider relocation of cable tray or the use of G-shaped Cable Tray. Where G-shaped cable tray is desired, submit an RFI identifying the desired change/location and the reason.

4. Where this clearance is not possible, project must reroute cable tray at no cost to the owner.

a) Cable tray may be relocated at the telecommunications sub-contractor discretion, provided that it is within the footprint of the same room(s) as indicated on the construction drawings, and the sub-contractor notes the new routing on the Record Drawings.

b) Where cable tray needs to be relocated above different room(s) than indicated on the construction drawings, Telecommunications Subcontractor is to submit an RFI with proposed new location.

B. For planning cable tray pathways, the maximum pathway fill shall be 25% by calculation, which appears to be approximately 50% full. Where installed cable quantities are expected to exceed this ratio, submit question during bid-window or as a construction RFI requesting possible up-size of the cable tray.

C. Follow all manufacturers’ instructions.

D. Coordinate with all other trades prior to installation.

E. Telecommunications cables shall not be supported by any other trades, and shall be fully-supported by independent methods (e.g., 3/8” threaded rod).

F. Grounding and Bonding
   1. Each cable tray section shall be properly bonded together with Listed splices or connections.
   2. Bond the cable tray to the telecommunications bonding and grounding system every 50’-60’.
   3. Refer to section 27 05 26 for additional grounding and bonding requirements in regards to cable tray.

3.2 CABLE TRAYS

A. Support cable trays every 5’ (or less, where specifically required by manufacturer instructions). The length between cable tray supports may exceed 5’; provide calculations along with product submittal indicating maximum distance given the worst-case load factor (for the area with the greatest density of cables). This support distance or less shall be maintained throughout the project.

END OF SECTION
SECTION 27 05 37
FIRESTOPPING SYSTEMS FOR COMMUNICATIONS CABLING

PART 1 - GENERAL

1.1 SUMMARY
A. This section shall govern the firestopping systems and installation as it relates to communications cabling. The intent of this section is to give the selection of an approved material and its installation by a qualified contractor.

1.2 RELATED DOCUMENTS
A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS' immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.
B. The following codes, as required by law:
   1. National Electric Code (NEC)
C. The following standards:
   1. TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
   4. ASTM E 814, “Fire Tests of Penetration Firestop Systems”.
   7. ANSI/UL1479, “Fire Tests of Through Penetration Firestops”.
D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
E. The following specification sections:
   1. Division 7 – Section 07 84 13 – Penetration Firestopping
   2. Division 27 – Section 27 00 00 – Communications

1.3 QUALITY ASSURANCE:
A. Provide firestopping systems that comply with the following requirements:
   1. Firestopping material shall be tested by a qualified testing and inspection agency. A qualified testing and inspection agency is UL, or another comparable agency performing testing (as approved by UT ITS).
   2. Only Firestopping products bearing the classification marking of qualified testing and inspection agency shall be used.
Installation craftpersons / technicians shall be by qualified and trained. Acceptable Installer qualifications are as follows:

1. FM Research approved in accordance with FM AS 4991.
2. Individuals or staff who are certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training and experience. A minimum of 1 year experience in the installation of manufacturer's products is required.
3. The Installers shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures.

1.4 DEFINITIONS:

A. Communications cabling – including telecommunications, audio/video, coaxial, and distributed antenna systems.
B. Conduit sleeve – a conduit that only penetrates a single wall for the purpose of providing a pathway for communications cabling into adjacent rooms.
C. Firestop Assembly – a manufactured product from a reputable company that is delivered to the contractor fully- or partially-assembled and when installed is rated as meeting the UL 1479 or ASTM E814 standards for fire testing and becomes part of a Firestop System for that particular type of installation.
D. Firestop System – a product or series of products from a reputable manufacturing company that when installed properly by the contractor meets the UL 1479 or ASTM E814 standards for fire testing for that particular type of installation.
E. Zero maintenance firestop assembly – a firestop assembly with a self-contained sealing system which shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to adjust, remove or reinstall firestop material.

1.5 SUBMITTALS:

A. Refer to Section 27 00 00 Communications for shop drawing example and additional shop drawing requirements.
B. On shop drawings and record drawings, indicate location of every communications firestopping system, as well as which UL applications test applies. (See shop drawing example in Section 27 00 00.)

PART 2 – PRODUCTS

2.1 GENERAL

A. Communications cable tray or ladder rack shall not be continued through a fire-rated wall. Stop the tray or ladder rack, install multiple zero-maintenance firestop assemblies, and continue tray or ladder rack on the other side. Ensure grounding of the cable tray is continuous through the wall.
B. Single Source: For all penetrations for communications openings through fire-rated walls and floors, install the same manufacturer’s product for that type of penetration throughout the project.
C. Identification
1. At all firestop locations, install a label on each side of the wall indicating the following information:
   a) Manufacturer of Firestop
   b) Name of product and UL System Number
   c) Name of installing contractor and date of installation.
   d) Rating of the wall/system.

2.2 ZERO-MAINTENANCE FIRESTOP ASSEMBLY
A. Shall meet or exceed the ratings of the wall or floor that it penetrates.
B. **Shall be used for communications cabling at all interior wall penetrations through a single, fire-rated wall or floor.**
C. Shall be a listed (UL and/or FM) firestopping assembly system tested to UL 1479 or ASTM E814. The assembly shall Assembly size and quantity shall be determined as follows:
   1. For round openings, fill ratio of cabling-to-opening-size shall not exceed 40%, or as dictated by the manufacturer, whichever is more stringent.
   2. For rectangular openings, fill ratio of cabling-to-opening size shall not exceed 50%, or as dictated by the manufacturer, whichever is more stringent.
   3. Include in cabling cross-sectional area enough spare capacity to accommodate 50% growth. Upon commissioning, if adequate spare capacity is not observed, contractor shall install additional assemblies at their own cost to provide such spare capacity.
D. Manufacturer shall be:
   1. Specified Technologies Inc., EZ Path Series 22, 33, or 44.
   2. Or approved equivalent

2.3 FIRESTOPPING FOR COMMUNICATIONS CONDUITS & OTHER APPLICATIONS
A. Required for all fire-rated wall penetrations where a communications pathway extends beyond a single fire-rated partition.
B. Required for all telecommunications outlets located on fire-rated walls. System shall be UL CLIV tested.
C. Shall be a listed (UL and/or FM) firestopping assembly system tested to UL 1479 or ASTM E814.
D. Shall meet or exceed the ratings of the wall or floor that it penetrates.
E. Manufacturer shall be:
   1. 3M – submit appropriate system and indicate on shop drawings where being utilized.
   2. Hilti - submit appropriate system and indicate on shop drawings where being utilized.
   3. Specified Technologies Inc. - submit appropriate system and indicate on shop drawings where being utilized.

**PART 3 - EXECUTION**
3.1 GENERAL

A. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.

B. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.

C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.

D. Do not use materials that contain flammable solvents.

E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

G. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

H. Before beginning installation:
   1. Examine effected surfaces, as they shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
   2. Provide masking and temporary covering to protect adjacent surfaces.
   3. Do not proceed until unsatisfactory conditions have been corrected.

I. Install through-penetration firestop systems in accordance with the conditions of testing and classification as specified in the published design. Comply with manufacturer’s instructions for installation of firestopping products.

J. After installation:
   1. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
   2. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.
   3. Commissioning of Firestopping Systems for Communications Cabling is to be in conjunction with the above ceiling inspection (as outlined in Section 27 00 00). All firestop systems (including cabling through them) and identification labels shall be installed prior to the Design Engineer above-ceiling inspection.

END OF SECTION
SECTION 27 05 39
SURFACE RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This section shall govern the products and installation of all necessary parts, pieces and accessories of a surface raceway system for communications cabling (data network, voice, video, fiber optic, and other low-voltage cables).

1.2 RELATED DOCUMENTS
A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.
B. The following codes, as required by law:
   1. National Electric Code (NEC)
C. The following standards:
   1. TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 SUBMITTALS
A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Product Information
      a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
   1. Manufacturer and Maintenance Manuals for all installed equipment.
      a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
      b) List of bill of materials, including all parts, pieces and connectors required for installation of the surface raceway.
   2. Deliver to owner any special tools produced by the manufacturer required to install or uninstall the surface raceway and/or raceway cover.

PART 2 – PRODUCTS

2.1 METALLIC RACEWAY
A. Size according to Execution section.
B. Manufacturer shall be:
2.2 NON-METALLIC RACEWAY
A. Size according to Execution section.
B. Manufacturer shall be:
   1. Panduit
   2. Wiremold
   3. Or approved equivalent

2.3 SURFACE OUTLET BOXES
A. Single-gang
   1. Minimum of 2-3/4” deep
   2. Manufacturer shall be:
      a) Panduit
      b) Wiremold
      c) Or approved equivalent

B. Double-gang
   1. Minimum of 2-3/4” deep
   2. Manufacturer shall be:
      a) Panduit
      b) Wiremold
      c) Or approved equivalent

PART 3 - EXECUTION
3.1 GENERAL
A. Follow all manufacturers’ instructions.
B. Coordinate with all other trades prior to installation.
C. Delivery, Storage, and Handling
   1. Store products in manufacturer’s unopened packaging until ready for installation.
   2. Store and handle in strict compliance with manufacturer’s written instructions and recommendations.
   3. Protect from damage due to weather, excessive temperature, and construction operations.
D. Verify routing locations of raceway prior to installation.
E. Surface raceways shall be sized to accommodate 1 square in of space per work area.
F. Do not begin installation until substrates have been properly prepared. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

G. Clean surfaces thoroughly prior to installation.

H. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

I. Install all components necessary to make a complete, code-compliant installation.

J. Sections of surface raceway less than 7’ in length shall be a single piece of raceway.

3.2 ELEVATOR PHONE AND DATA CONNECTIONS

A. Inside CCTV Enclosure, install (1) surface-mounted, double-gang box (Ortronics OR-40300186 or Panduit JBP2D).

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of identification and labeling of all required parts, pieces and accessories of the communications cabling system, which shall include, but is not limited to, cabling, faceplates, patch panels, 110-blocks, conduit, innerduct, junction and pullboxes, firestop locations, and the communications grounding system.

B. Contractor shall also supply a cable manifest (spreadsheet) prior to construction for all backbone and horizontal cabling links, which shall identify the cable type, the starting and ending points of each cable, include pair/strand count, and indicate the label content on both ends (at the faceplate or telecommunications room termination). An updated cable manifest shall be delivered with substantial completion.

1.2 RELATED DOCUMENTS

A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.

B. The following codes, as required by law:
   1. National Electric Code (NEC)

C. The following standards:
   1. TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure

D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 QUALITY ASSURANCE:

A. All labels shall be machine-printed, crisp, clear, non-smearing and extremely legible. Labels shall be durable for the life of the system (the 15+ year system warranty); labels which can be easily removed shall not be utilized.

1.4 DEFINITIONS:

A. Uplink Cables – Where Communications Rooms are within 295 cabling feet of the Main Communications Room (MDF), they are to be connected back to the MDF by several Category 5e Uplink Cables. These act as backbone cables, and should be treated as such.

1.5 COORDINATION WITH ITS ASSIGNMENT OFFICE:

A. Prior to submission of pre-construction submittals, coordinate with UT ITS Representative for an owner-provided labeling scheme to be followed for each building.
   1. ITS will provide a two (or three if applicable) digit designation for each Communication Room. Examples: 1A, 1B, 2A, 2B, etc.
   2. ITS will provide both copper and fiber backbone cable identifiers.
3. Refer to the subsequent sections for additional instructions.

B. Failure to coordinate with UT ITS on labeling and identification schemes in a timely manner, and/or failure to follow the requirements of this section may result in the project’s Substantial Completion not being met.

1.6 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:

1. Product Information Submittals
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
   b) For planned labeling for all outlets/horizontal cables and backbone cabling:
      1) Provide a complete list, in Microsoft Excel format, of the planned identification labels for all outlets/horizontal cables and backbone cables.
      2) Await approval or corrections by UT ITS for labeling scheme prior to printing/applying labels.

2. Shop Drawings
   a) Planned labeling for outlets:
      1) Provide scaled drawings of the floor plans showing all outlets with the proposed identification label for each outlet.
   b) Communication Rooms and Backbone Cabling:
      1) Provide a riser diagram that indicates each Communications Room by both room number and two letter ITS designation. Also indicate the ITS-provided backbone cable identifiers on this riser diagram, including Uplink Cables. UT ITS will provide specific labeling scheme using the Uplink Cable information provided.
   c) Planned labeling for racks and patch panels:
      1) Provide enlarged scaled drawings of each communication room indicating Rack Row and Number.
      2) Refer to the Execution section for additional information, including Rack Row/Number and Patch Panel labeling.

B. The following submittals are due prior to Substantial Completion, in accordance with the submittal requirements in Section 27 00 00 Communications:

1. Record Drawings
   a) Updated shop drawings (now identified as Record Drawings) with any additions or changes as required during the course of construction.

2. Cable Manifest
   a) Provide cable manifest (spreadsheet) identifying source, destination, pair/strand count, and labeling scheme used for each horizontal and backbone cable.
b) This file shall be readable with Microsoft Excel (2007 Version) with formatting intact.
c) Submit this file on USB Flash Drive or CD/DVD-R specific for Div. 27 Record Drawings. Refer to Section 27 00 00 for additional information.

PART 2 – PRODUCTS

2.1 GENERAL
A. All labels or means of identification shall utilize machine-printed type.

2.2 HANDHELD LABELERS
A. To be utilized for ISP cable labels, OSP (horizontal) cables, racks, and grounding busbars.
B. Size according to cable diameter and readability.
C. Shall be thermal-transfer type, and utilize self-adhesive labels.
D. Approved manufacturers:
   1. Brady, IDXPERT
   2. Dymo, Rhino
   3. Hellermann Tyton, Spirit 2100
   4. Panduit, LS8E or LS9
   5. Or approved equivalent
E. Alternatively, a thermal transfer desktop printer may be utilized with self-adhesive labels/rolls. Submit manufacturer and part number to be considered.

2.3 FACEPLACE, PATCH PANEL, AND WALL-BLOCK LABELS
A. Faceplates, patch panels and wall-blocks shall have integral slots for label inserts. Have identification machine-printed onto label inserts and populate the integral slots with these inserts.
B. Where intended-product does not have an integrated label insert, submit proposed labeling method.

2.4 GROUNDING AND BONDING CONDUCTORS
A. Warning Marker
   1. Non-metallic, machine and pre-printed as a wrap-around marker (not a flag marker).
   2. Manufacturer shall be:
      a) Panduit, LTYK
      b) Or approved equivalent
B. Identification Label
   1. Label shall be self-laminating, machine- and thermal-printed.
   2. Size of label will vary with size of conductor:
      a) For 18-14AWG, 1.00”x0.75” label
      b) For 12-10AWG, 1.00”x1.25” label
c) For 8-4AWG, 1.00"x2.25" label
d) For 2-1AWG, 1.00"x4.00" label
e) For 1/0-250kcmil, 1.00"x6.50" label

3. Manufacturer shall be:
a) Panduit, S100X***VAC or S100X***VAT, where *** is the second dimension.
b) Equivalent from Brady or Hellermann Tyton
c) Or approved equivalent

PART 3 - EXECUTION

3.1 GENERAL
A. Install labels in such a way as to be physically and visually accessible.
B. Remove any temporary labels and ensure no permanent labels are damaged during construction.
C. Replace all damaged or missing permanent labels prior to substantial completion.

3.2 LABELING OF CABLELING SYSTEMS
A. General
1. Communications Room (Terminal Room) numbering is determined by the ITS Assignment Office. Coordinate with UT ITS Representative prior to submitting pre-construction shop drawings to obtain labeling scheme. Examples offered here are for preliminary purposes only. Final direction is to come from ITS during construction.
   a) Example of numbering scheme:
      NAME=FL/TR
      SAC 0.102=BA
      SAC 1.602 =1A
      SAC 1.202 =1B
      SAC 2.406=2A
      SAC 2.202=2B
      SAC 3.202=3B
      SAC 4.102A=4A
      SAC 5.110=5A
   b) The first number/letter indicates the floor (Basement, 1st, 2nd, etc.); the second letter indicates the particular communications room on that floor (A, B, C, etc.) For buildings with more than 9 floors, each floor will have a leading zero (ex: 01, 09.10, 11, etc.)
2. Buildings that are part of (attached) to another may need the source building’s three letter building code incorporated into the labeling scheme. Coordinate with UT ITS prior to submitting proposed labeling scheme to determine if the building suffix is needed.
B. Equipment Racks
1. Racks in each communications room are to be labeled (minimum text height of 3/8").
2. Racks are to be numbered left to right, from front of room to back.

3. Label shall also include Terminal Room number before rack number.
   a) Example “Rack 2A1”, for Rack 1 in Terminal Room 2A.

4. For any Communications Room with more than 9 racks, rack 1-9 must include ‘0’ prefix.
   a) Example “Rack 2A01” for Rack 1 of 11 in Terminal Room 2A.

C. Patch Panels

1. Label the center of the patch panel with the PP# (ex: A-Z, top to bottom; skipping I and O). Each rack starts over with a new rack number and patch panel alpha labeling scheme from A-Z top to bottom (skipping I and O).
   a) For patch panels exclusively serving wireless access points, add “WF” as a suffix.

D. Terminations for Patch Panels and 110-blocks

1. Utilize available inserts: print with inkjet or laser printer.
   a) Include full labeling scheme if size permits.
      1) Example: 1A1A01**
         i) 1st floor
         ii) Terminal Room A
         iii) Rack #1
         iv) Patch Panel A
         v) Position #01
         vi) ** Add WF suffix for all outlets for wireless access points.,
              FC for security video fixed camera, and PTZ for security video pan tilt zoom camera.

E. Inside Plant (ISP) Horizontal Category Cable

1. Label within 6" at both termination ends.
   a) Example: 1A1A01**
      1) 1st floor
      2) Terminal Room A
      3) Rack #1
      4) Patch Panel A
      5) Position #01
      6) ** Add WF suffix for all cables for wireless access points, FC for security video fixed camera, and PTZ for security video pan tilt zoom camera.

2. For cables routed through junction boxes and pull boxes, group all cables together by destination (room) via velcro-strap, and flag (identify) that destination near the velcro-strap.

F. Outside Plant (OSP) Category Cable (horizontal cabling)
1. Label transition point (if utilized) as COMMUNICATIONS OSP TRANSITION POINT.

2. Label all cables within transition point within 6” of termination ends.
   a) Example: 1A1A01
      1) 1st floor
      2) Terminal Room A
      3) Rack #1
      4) Patch Panel A
      5) Position #01

G. CATV (coaxial) cable labeling
   1. Label within 6” at both termination ends and on faceplate.
      a) Horizontal Cables:
         1) Format: 2-Digit ITS Comm Room Designation – Room # - Outlet # for that Room
         2) Example: 2B-3.208B-1
            (i) 2 = Floor number (will vary)
            (ii) B = Terminal Room Identifier (will vary)
            (iii) 3.208B indicate Room Number
            (iv) 1 = indicates sequential CATV identifier for that room.
      b) Backbone Cables:
         1) Format: CATV – Source Room (with 2-Digit ITS Designation) – Destination Room (with 2-Digit ITS Designation)
         2) Example: CATV – 2.212A (2A) – 3.412 (3A)

H. Faceplates / Work Area Outlets
   1. Utilize faceplate label inserts if available: print with inkjet or laser printer. Otherwise, use handheld printer with adhesive label for application directly onto faceplate. Labels are to have straight edges and alignment.
      a) For Category 5e jacks
         1) Example: 1A1A01**
            (i) 1st floor
            (ii) Terminal Room A
            (iii) Rack #1
            (iv) Patch Panel A
            (v) Position #01
      b) For Category 6A jacks
         1) Example: 1A1A01**
            (i) 1st floor
(ii) Terminal Room A
(iii) Rack #1
(iv) Patch Panel A
(v) Position #01
(vi) ** Add WF suffix for all cables for wireless access points, FC for security video fixed camera, and PTZ for security video pan tilt zoom camera.

(vii)

I. Copper Backbone (between Telecom Rooms)
   1. Label within 6" at both ends of cable with the following information:
      a) ITS Designation – DESTINATION (TR#)
      b) Example: R2N – 3.336 (3A)

J. Fiber Backbone (between Telecom Rooms)
   1. Cable - Label within 6" at both ends of cable with the following information:
      a) ITS Designation – STRANDS – DESTINATION (TR#)
      b) NAME shall follow the following format:
         1) OFMM### for multimode
         2) OFSM### for singlemode
         3) Coordinate with UT ITS for ### for fiber cables.
      c) Example: OFSM511 – STRANDS 1-12 – SZB 336 (3A)

3.3 PATHWAYS

A. Conduit
   1. Label exterior of conduit as COMMUNICATIONS (unless otherwise noted on the drawings) with text readable from a standing position on the finished floor.
      a) For wall stub-up locations, label overhead only.
      b) For strictly overhead conduits, label both ends.
      c) For long runs of conduits that stub directly up or into Communications Room, label the end of the conduit in the Communications Room with the destination room number or location.
         1) Examples: FLOOR BOX ROOM 2.302, EMERGENCY CALL BOX NW CORNER OF BUILDING, ELEVATOR EQUIPMENT ROOM 1.402.
   2. Sleeves which pass through a single wall or floor need not be labeled.

B. Junction boxes and pull boxes
   1. Label exterior of junction boxes and pull boxes as COMMUNICATIONS with text readable from a standing position on the finished floor.
      a) Preferred method is to paint ITS on the lid in blue paint.

C. Firestop locations
1. All communications firestop locations are to be labeled on both sides of wall or floor. Refer to firestopping specification section for additional information.

3.4 GROUNDING

A. Label TMGB as FLOOR# - ROOM# - TMGB.
B. Label TGBs as FLOOR# - ROOM# - TGB.
C. Label grounding conductors within 12” of both ends with Warning Marker and Identification Label.

1. Identification label is to include the source and destination of the grounding conductor.

END OF SECTION
SECTION 27 08 10
OPTICAL FIBER TESTING AND MEASUREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings, Contract Forms, Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement, Exhibits and other Specification Sections that apply to this section.

1.2 SCOPE OF WORK
A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete and proper test measurements of the installed optical fiber cabling.
B. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the optical fiber testing with other applicable trades.
C. In addition to the test regiment detailed in this document, the contractor shall notify the Owner or the Owner’s representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.
D. The contractor shall provide all test measurement results two (2) weeks prior to substantial completion in manifest spreadsheet format and native file format from the test instrument. Software shall also be provided to view the native results.

1.3 SCOPE
A. Test measurements shall be carried out in accordance with the Tier 2 specification of ANSI/TIA-568-C.0, Annex E, plus an image capture of connector end-faces. Tier 2 testing is a higher level of testing that provides qualitative measures of the installed condition and performance of the cabling system and its components. Tier 2 testing includes length measurement, attenuation measurement, verifying polarity (using an optical loss test set (OLTS) and obtaining a trace and event table of the fiber with an optical time domain reflectometer (OTDR). OTDR traces are used to evaluate the installed cabling for anomalies and assuring uniformity of cable attenuation and connector insertion loss.
B. Testing shall be performed on each optical fiber cabling link (adapter to adapter).
C. All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode (850nm and 1300nm) and singlemode links (1310nm and 1550nm), OLTS length measurements for multimode and singlemode links, OTDR traces and event tables for multimode and singlemode links, and image captures of connector end-faces.

1.4 DEFINITIONS
A. Optical fiber cabling link: A fiber with an adapter on each end.

1.5 QUALITY ASSURANCE
A. All testing procedures and field-test instruments shall comply with applicable requirements of:
   1. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
3. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
4. ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.
5. ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
8. ANSI/TIA -568-C.0, Generic Telecommunications Cabling for Customer Premises.

B. Trained technicians who have successfully attended an optical fiber testing training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.
2. Manufacturer of the test equipment used for the field certification.
3. Training organizations (e.g., BICSI, A Telecommunications Association).

C. The Owner or the Owner’s representative shall be invited to witness, review or both witness and review field-testing.
1. The Owner or the Owner’s representative shall be notified of the testing start date, five (5) business days before testing commences.
2. The Owner or the Owner’s representative will select a random sample of 5% of the installed links and test that sample. The measured results obtained from the random sample shall be compared to the data provided by the contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor under supervision of the Owner or Owner’s representative shall repeat 100% of the testing at no cost to the Owner.

1.6 SUBMITTALS
A. Manufacturers catalog sheets and specifications for the fiber optic field-test instruments including optical loss test sets (OLTS), optical time domain reflectometer (OTDR) and endface inspection capture device.
B. A schedule (list) of all optical fibers to be tested identified per UT Administration Office specifications.
C. Sample test reports.

1.7 ACCEPTANCE OF TEST RESULTS
A. Link attenuation measurement and allowance calculation
1. The measured link attenuation shall be less than the link attenuation allowance. The link attenuation allowance is calculated as:

\[
\text{Link Attenuation Allowance (dB)} = \text{Cable Attenuation Allowance (dB)} + \text{Connector Insertion Loss Allowance (dB)} + \text{Splice Insertion Loss Allowance (dB)}
\]

where:

- \[
\text{Connector Insertion Loss Allowance (dB)} = \text{Number of Connector Pairs} \times 0.4\text{dB}
\]
- \[
\text{Splice Insertion Loss Allowance (dB)} = \text{Number of Splices} \times 0.15\text{dB}
\]
- \[
\text{Cable Attenuation Allowance (dB)} = \text{Maximum Cable Attenuation Coefficient (dB/km)} \times \text{Length (km)}
\]

### Optical fiber cable attenuation performance

<table>
<thead>
<tr>
<th>Optical fiber and cable type</th>
<th>Wavelength (nm)</th>
<th>Maximum attenuation (dB/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.5/125 µm Multimode (OM1)</td>
<td>850</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1.5</td>
</tr>
<tr>
<td>50/125 µm Multimode (OM2)</td>
<td>850</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1.5</td>
</tr>
<tr>
<td>850 nm Laser-Optimized 50/125 µm Multimode (OM3)</td>
<td>850</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1.5</td>
</tr>
<tr>
<td>Single-Mode Indoor-Outdoor (OS1) (OS2)</td>
<td>1310</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>0.5</td>
</tr>
<tr>
<td>Single-Mode Indoor Plant (OS1) (OS2)</td>
<td>1310</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>1.0</td>
</tr>
<tr>
<td>Single-Mode Outdoor Plant (OS1) (OS2)</td>
<td>1310</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>0.5</td>
</tr>
</tbody>
</table>

B. All installed cabling links shall be field-tested and pass the link attenuation measurement and allowance calculation and OTDR analysis. Any optical fiber link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Part 3.

C. Individual connector, splice and fiber insertion loss shall be evaluated using the OTDR trace. These components shall meet or exceed the values in 1.7, A.

### PART 2 - PRODUCTS

#### 2.1 OPTICAL FIBER CABLE TESTERS

A. The field-test instrument shall be within the calibration period recommended by the manufacturer.

B. The field-test instrument shall contain the most recent software and firmware provided by the manufacturer prior to testing.

C. Optical loss test set (OLTS)

1. The OLTS shall be capable of providing length measurement of the fiber under test.
2. Multimode optical fiber light source
a) Provide dual LED light sources with central wavelengths of 850 nm (±30 nm) and 1300 nm (±20 nm).
b) Output power of -20 dBm minimum.
c) The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (see Part 3, 3.2, C, 1, c) with a Category 1 light source.

3. Singlemode optical fiber light source
   a) Provide dual laser light sources with central wavelengths of 1310 nm (±20 nm) and 1500 nm (±20 nm).
   b) Output power of –10 dB minimum.

4. Power Meter
   a) Provide 850nm, 1300nm and 1500nm wavelength test capability.
   b) Power measurement uncertainty of ± 0.25 dB.
   c) Store reference power measurement.
   d) Save at least 100 results in internal memory.
   e) PC interface (serial or USB).

5. Acceptable manufacturers, models:
   a) Fluke Networks, OptiFiber (OLTS and OTDR combined)
   b) Fluke Networks, DTX (OLTS; MFM2, SFM2)
   c) Corning Cabling Systems OTS-613QD (OLTS)
   d) Exfo, FOT-600 OLTS (OLTS)
   e) Approved equivalent

D. Optical Time Domain Reflectometer (OTDR)
   1. Shall have a bright, color transmissive LCD display with backlight.
   2. Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
   3. Internal non-volatile memory and removable memory device with at least 16 MB capacity for results storage.
   4. Serial and USB ports to transfer data to a PC.
   5. Multimode OTDR
      a) Wavelengths of 850 nm (± 20 nm) and 1300 nm (± 20 nm).
      b) Event deadzones typically of 0.5 m at 850 nm and 1.3 m at 1300 nm.
      c) Attenuation deadzones 4.5 m at 850 nm and 10.5 m at 1300 nm.
      d) Distance range 3 km at 850 nm and 7 km at 1300 nm.
      e) Dynamic range 15 dB at 850 nm and 14 dB at 1300 nm.
   6. Single-mode OTDR
      a) Wavelengths of 1310 nm (± 25 nm) and 1550 nm (± 30 nm).
b) Event deadzones typically of 1 m at 1310 nm and 1 m at 1550 nm.
c) Attenuation deadzones typically of 8 m at 1310 nm and 8 m at 1550 nm.
d) Distance range at least 60 km.
e) Dynamic range 26 dB at 1310 nm and 24 dB at 1550 nm.

7. Acceptable manufacturers, models:
   a) Fluke Networks, OptiFiber (OLTS and OTDR combined with end face image capture)
   b) Fluke Networks, DTX (QUAD-OTDR)
   c) Corning Cabling Systems, OV-1000 OTDR
   d) Exfo, FTB-150 OTDR
   e) Approved equivalent

E. Fiber Microscope
   1. Magnification of 250X or 400X for end-face inspection
   2. Video camera and display showing magnified end-face image.
   3. Camera probe tips permitting inspection through adapters.
   4. Capable of saving end-face image.
   5. Acceptable manufacturers, models:
      a) Corning Cabling Systems, VIP-CCO-K17
      b) Fluke Networks, OptiFiber (OLTS and OTDR combined with end face image capture)
      c) Approved equivalent

F. Administration
   1. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
   2. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

PART 3 - EXECUTION

3.1 GENERAL

A. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

NOTE – A visible fault locator (VFL) normally uses a Class 2 or 3 light source and should not be directly viewed. Safe usage of the tool requires indirect viewing of the light source by pointing the end of the fiber at an adjacent surface (or introducing another surface in front of a fixed mounted connector) until the presence of light is determined.

B. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.
C. Dust caps shall be placed on fiber endfaces or adapters for each optical fiber link after all testing is complete on the fiber link.

D. Testing shall be performed in accordance with ANSI/TIA-568-C.0 Annex E, Tier 2 testing on each cabling segment (i.e., verify polarity, measuring length, OLTS attenuation measurement, and OTDR trace).

E. In addition to Tier 2 testing of ANSI/TIA-568-C.0 Annex E, an image of each fiber optic connector endface shall be taken, recorded and provided as part of the records.

F. Optical fiber link test results from the OLTS, OTDR and endface image shall be recorded in the memory of the field-test instrument.

G. Each optical fiber test shall be uploaded to a PC in which the administrative documentation (reports) shall be generated.

H. The records for each test shall be provided to the owner a minimum of two weeks prior to substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractor’s use.

3.2 OPTICAL FIBER TESTING

A. Polarity
   1. For duplex connector systems, polarity shall be verified. The polarity shall be verified with an OLTS while performing attenuation tests.

B. Length measurement
   1. Each optical fiber link shall be measured for its length. The fiber length may be obtained by a capable OLTS or by an OTDR.

C. Attenuation measurement (OLTS)
   1. General
      a) Optical sources shall be turned on for a minimum of 5 minutes prior to referencing.
      b) Test jumpers shall be reference quality and between 1m and 5m in length.
      c) Mandrels shall be used when testing attenuation of multimode optical fiber cabling with an OLTS. The mandrel sizes are shown in the following table

      | Fiber core/cladding size (μm) | 900 μm buffered fiber (mm) | 2.0 mm jacketed cable (mm) | 2.4 mm jacketed cable (mm) | 3.0 mm jacketed cable (mm) |
      |-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
      | 50/125                      | 25                          | 23                          | 23                          | 22                          |
      | 62.5/125                    | 20                          | 18                          | 18                          | 17                          |

      d) Where mandrels are used, secure the mandrel to the light source by some means such as a cable tie or tape. Care should be taken to ensure that the fiber jacket is not deformed or damaged when using a cable tie or tape.
e) The light source shall be referenced to the meter a minimum of twice
daily (i.e., in the morning and noon).

f) Fiber test jumpers shall be of the same core size as the cabling under
test (e.g., singlemode to singlemode, 62.5µm multimode to 62.5µm
multimode, 50µm multimode to 50µm multimode). Additionally the test
jumpers shall meet the performance specifications of the fiber under test
and that of the test instrument manufacturer.

g) Fiber test jumpers shall be cleaned prior to connection to the test
instrument. After cleaning, cleaning solutions shall be given sufficient
time to evaporate (approximately 30 seconds) prior to the mating of fiber
test jumper to the test instrument.

h) The end of the fiber test jumper that will connect to the fiber link to be
tested, the adapters and fiber under test shall be cleaned immediately
prior to each fiber being tested. After cleaning, cleaning solutions shall
be given sufficient time to evaporate (approximately 30 seconds) prior to
the mating of fiber test jumper to the fiber under test.

i) The test jumper connected to the source shall not be removed after
referencing so as not to adversely influence the attenuation
measurement. Removal and reattachment of the test jumper connection
from the source may affect the referenced power level. Re-referencing
is to be performed if the test jumper is disconnected from the light
source.

j) Singlemode optical fiber links shall be tested at 1310 nm and 1550 nm
in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference
Jumper.

k) Multimode optical fiber links shall be tested at 850 nm and 1300 nm in
accordance with ANSI/TIA/EIA-526-14-A, Method B, One Reference
Jumper.

l) Multimode and singlemode optical fiber links shall be measured and
reported for attenuation in each direction and attenuation bi-directionally
(averaged in both directions). The measurements shall be less than or
equal to the link attenuation allowance calculation (see Part 1, 1.7, A.).

2. Steps to measure and calculate optical fiber link attenuation include a) verifying
test jumper quality; b) setting the reference; c) measuring link attenuation; and
d) calculating link attenuation.

This example below describes the process when testing multimode fiber with
the test jumper connected to the source having five non-overlapping wraps of
multimode fiber on a mandrel. The procedure is also applicable to single-mode
cabling, however, the five non-overlapping wraps of multimode fiber would be
replaced with a single 30 mm (1.2 in) diameter loop of single-mode fiber.

a) Verifying test jumper quality

1) Test jumpers shall be tested for quality prior to use as a test
jumper. See example below.

To verify that the test jumpers are in acceptable condition, first
reference the light source to the optical power meter (see figure
1). Disconnect test jumper (J1) from the power meter (only) and
insert a second test jumper (J2) by connecting it to the power meter and to (J1) with a mating adapter (see figure 2) and record the measurement. Disconnect both ends of J2, interchange the ends, and reconnect it and record the measurement. The resulting measurements, $P_{\text{verify}}$, should be within the appropriate connector loss specification. For example, if the connector used is specified at 0.32 dB, the reading on the power meter should be within 0.32 dB of $P_1$.

Figure 1 – Example of OLTS reference measurement ($P_1$) with one test jumper (multimode)

Figure 2 – Example of a measurement ($P_2$) when verifying OLTS test jumpers (multimode)

b) Setting the reference

1) One test jumper (J1) is to be connected between the light source and the power meter and a reference measurement taken ($P_1[\text{dBm}]$). When testing a multimode optical fiber link, a mandrel wrap shall be applied to the test jumper (J1) prior to setting the reference and for all subsequent measurements.
When testing a singlemode optical fiber link, a single 30 mm (1.2 in) diameter loop shall be applied to the test jumper (J1) prior to setting the reference and for all subsequent measurements.

![Diagram of singlemode fiber link with loop](image)

**Figure 3 – Example of OLTS reference measurement ($P_1$) with one test jumper (multimode)**

c) Measuring link attenuation

1) Connect the end of test jumper (J1) (source end) to one end of the link, and connect an verified test jumper (J2) between the other end of the link and the meter (see figure 4). The optical power reading is $P_2$ (dBm).

![Diagram of multimode link attenuation measurement](image)

**Figure 4 – Example of a multimode link attenuation measurement ($P_2$)**
d) Calculating link attenuation
Link attenuation shall be calculated by the OLTS. Calculated optical fiber link attenuation is applied by using the following equation.

\[ \text{Attenuation (dB)} = P_1 (dBm) - P_2 (dBm) \]

where:
\[ P_1 = \text{Reference power measurement} \]
\[ P_2 = \text{Cabling test power measurement} \]

3. Link attenuation measurement and allowance calculation
a) The measured link attenuation shall be less than the link attenuation allowance (see Part 1, 1.7, A.).

D. Optical fiber endface image
1. An image of each optical fiber endface shall be taken and recorded after Tier 2 testing of the optical fiber link is completed. The endface image shall be captured at either 250X or 400X.

E. OTDR trace
1. An OTDR trace shall be taken of each optical fiber link in one direction to ensure uniformity of cable attenuation and connector insertion loss. Multimode fiber traces shall be taken at 850nm and 1300nm. Singlemode fiber traces shall be taken at 1310nm and 1550nm.
2. A launch cable to the length specified by the manufacturer of the OTDR shall be installed between the OTDR and the first link connection. The launch cable shall be of the same fiber type as the link under test.
3. A receive cable shall be installed after the last link connection to be part of the OTDR trace. The receive cable shall be at least 100m (328ft) in length and of the same fiber type as the link under test.
4. Selectable parameters affecting the OTDR measurement may include the test source wavelength, pulse duration or signal strength, length range, backscatter coefficient, signal averaging (time or count) and the group index of the fiber (also known as the index of refraction or the refractive index). The display shall be adjusted to view the region of interest on the trace on both the horizontal and vertical axes.

Figure 5 – OTDR setup illustration of fiber link testing
3.3 ADMINISTRATION

A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”.

2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period. The contractor shall retain a copy to aid preparation of as-built information.

3. The records for each test shall be provided to the owner a minimum of two weeks prior to substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractors use.

4. Circuit IDs reported by the field-test instrument shall match the label ID specified by the Owner.

5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information:
   a) The identification of the customer site as specified by the end-user
   b) The name of the standard selected to execute the stored test results
   c) The name of the test personnel
   d) The date and time the test results were saved in the memory of the tester
   e) The manufacturer, model and serial number of the field-test instrument
   f) The version of the test software and the version of the test standards database held within the test instrument
   g) The value of the ‘index of refraction’ used for length calculations
   h) The fiber identification number
   i) The length for each optical fiber calculated by the OLTS.
   j) Test results to include OLTS attenuation link and channel measurements at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
   k) Test results shall be submitted to include OTDR link and channel traces and event tables at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
   l) The length for each optical fiber calculated by the OTDR.
   m) The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
   n) A picture or image of each fiber end-face

END OF SECTION
SECTION 27 08 20
COPPER TESTING

PART 1 - GENERAL

1.1 SUMMARY
A. Test measurements shall be taken for all balanced-twisted pair cabling, including horizontal and backbone copper cables and wall-to-rack cables. Test all category cables in accordance with current TIA measurement specifications for that category of cabling with a field-test instrument meeting or exceeding Level IV accuracy. Provide test measurement results (in electronic format) a minimum of three weeks prior to substantial completion.

1.2 RELATED DOCUMENTS
A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.
B. The following standards:
   1. ANSI/TIA-568-C.2 –Balanced Twisted-Pair Telecommunications Cabling and Components Standard
   2. ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
C. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 QUALITY ASSURANCE
A. All testing procedures and field-test instruments shall comply with applicable requirements of:
   1. ANSI/TIA-568-C.2
   2. ANSI/TIA-1152
B. Test measurements shall be performed by trained technicians who have successfully attended manufacturer training or BICSI Installer 2 copper training.
C. The Owner or the ITS Representative shall be invited to witness, review or both witness and review field-testing.
   1. Notify ITS Representative and Design Engineer of the testing start date, five (5) business days before testing commences.
   2. After final test measurements have been completed and submitted, the ITS Representative or Design Engineer will select a random sample of up to 10% of the installed links that the telecommunications contractor is to retest at no cost to the Owner. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor, under supervision of the ITS Representative, shall repeat 100% of the testing at no cost to the Owner.

1.4 SUBMITTALS
A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:

   1. Names of individuals that will be performing the testing and their training certificates (from BICSI or manufacturer).

   2. Manufacturer’s cutsheet or specifications sheet for the field-test instrument to be used, along with calibration data sheet.

   3. Sample Test Report, which shall show that the field-test instrument software and firmware is up-to-date (the most recent version). This sample test report shall also show all required test parameters as required by the referenced standards.

B. The following submittals are due a minimum of three weeks prior to substantial completion, in accordance with the submittal requirements in Section 27 00 00 Communications:

   1. Complete test measurement results indicating that all cable permanent links have passed. Submit (2) electronic versions on (2) CD/DVD-R or USB Flash Drive (one for the ITS Representative and one for the Design Engineer):

      a) Microsoft Excel 2007 (Manifest)

      b) Test measurement results in their native format and the manufacturer’s PC software to read test results.

C. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:

   1. On final electronic file submittal (CD/DVD-R or USB Flash Drive), which is to include record drawings, O&M manuals, etc., also include files for all valid test results (as submitted previously).

PART 2 - PRODUCTS

2.1 FIELD-TEST INSTRUMENT

A. The field-test instrument shall:

   1. Be within the calibration period recommended by the manufacturer.

   2. Contain the most recent software and firmware provided by the manufacturer prior to testing.

   3. Be a Level IV accuracy (Or greater)

B. Administration

   1. The test measurement result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.

   2. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

C. Manufacturer shall be:

   1. Agilent

   2. Fluke

   3. Or Approved Equivalent
PART 3 - EXECUTION

3.1 GENERAL

A. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any test measurements performed on incomplete systems shall be redone on completion of the work.

B. The records for each cable test measurement shall be provided to the owner a minimum of three weeks prior to substantial completion in Excel format (manifest) and the native format to the field-test instrument. The Owner can supply an Excel spreadsheet template (manifest) upon request for the contractor's use.

C. The installed twisted-pair links shall be tested from the telecommunications room to the telecommunication wall outlet in the work area for compliance with the “Permanent Link” performance specification.

D. One hundred percent of the installed cabling links shall pass the requirements of the referenced standards. Any failing link shall be diagnosed and corrected. The corrective action shall be noted and followed with a new test measurement to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test measurements results documentation.

E. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. The test equipment (tester) shall comply with the accuracy requirements for Level IV field-test instruments as defined in ANSI/TIA-1152. The field test instrument, including the appropriate interface adapter, shall meet Level IV accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the Channel configuration).

F. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*. The “*” shall not be turned off on the test instrument.

G. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field-test instrument manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent ‘*’ results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

3.2 PERFORMANCE TEST PARAMETERS

A. Test parameters for category 3 Cables:
   1. Wire map
   2. Length
   3. Insertion loss
   4. Pair-to-pair near-end crosstalk (NEXT) loss
   5. Propagation delay
6. Delay skew

B. Test parameters for category 5e cables (up to 100MHz) and category 6 cables:
   1. Wire Map
   2. Length
   3. Insertion Loss
   4. NEXT loss
   5. PSNEXT
   6. ACRF
   7. PSACRF
   8. Return Loss
   9. Propagation Delay
   10. Delay Skew

C. Test parameters for other cables:
   1. Continuity to the remote end;
   2. Shorts between any two or more conductors;
   3. Crossed pairs;
   4. Reversed pairs;
   5. Split pairs; and,
   6. Any other mis-wiring.

3.3 ADMINISTRATION

A. Test results documentation
   1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”.
   2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period. The contractor shall retain a copy to aid preparation of as-built information.
   3. The records for each test shall be provided to the owner a minimum of three weeks prior to substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractors use.
   4. Circuit IDs reported by the field-test instrument shall match the label ID specified by the Owner.
   5. The detailed test results documentation data is to be provided in an electronic database for each tested link and shall contain the following information
      a) The identification of the customer site as specified by the end-user
      b) The name of the standard selected to execute the stored test results
      c) The name of the test personnel
d) The date and time the test results were saved in the memory of the tester

e) The manufacturer, model and serial number of the field-test instrument

f) The version of the test software and the version of the test standards database held within the test instrument

g) The copper identification number

h) The length for each copper cable

i) The overall Pass/Fail evaluation of the channel test.

END OF SECTION
SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes basic communications room requirements. Refer to “T” series drawings for specific communication room requirements.
B. The design of communications rooms depend on the size of the building, floor space served, occupant needs, services deployed and future growth.

1.2 SCOPE OF WORK
A. Provide all labor, materials, tools and equipment required for the complete and proper communications equipment room fittings installation.
B. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the communications equipment room fittings installation with other applicable trades.
C. In addition to the details specified within this Section, the contractor shall notify the ITS Representative of any additional items deemed necessary to guarantee a fully functional system. The contractor shall furnish and install all necessary items for a fully functional system at no additional charge.

1.3 DEFINITIONS
A. communications room: A generic term for an equipment room or telecommunications room.
B. entrance room: A space in which the joining of campus and building telecommunications backbone facilities takes place.
C. equipment room: An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect and security equipment.
D. telecommunications room: An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling and security equipment.

1.4 RELATED DOCUMENTS
A. Drawings, Contract Forms, Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement, Exhibits and other Specification Sections that apply to this section.
B. Codes and standards
   1. The publications listed below form a part of this specification. The publications are referred to in the text by their basic designation only.
   2. Specific reference to codes, rules, regulations, standards, manufacturer’s instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
      a) ANSI-J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
b) ANSI/NFPA 70, National Electrical Code

b) ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure

d) NECA/BICSI-568, Installing Commercial Building Telecommunications Cabling

e) ANSI/NECA/BICSI-607, Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

f) TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces

g) Local, county, state and federal regulations and codes in effect as of the date of installation.

h) Equipment of foreign manufacture shall meet U.S. codes and standards. Submittals shall indicate any product of foreign manufacture and the country of origin.

1.5 COMMUNICATIONS ROOM REQUIREMENTS

A. There shall be as few communications rooms as necessary within a building.

B. The length of horizontal cable from each communications room shall be a maximum of 295 electrical cable feet (physical cable length is shorter due to the pair-twist within the cable). Notify Design Engineer of any outlets where a cable run of less than 295 feet is not possible.

C. The equipment room and telecommunications room designs, including location should be developed in accordance with the security plan of the building.

D. Each building shall contain an equipment room (gateway). The equipment room serves the building and contains the main cross-connect for optical fiber and copper twisted-pair as well as electronics (e.g., Ethernet router, switches). The equipment room may contain the entrance facility (e.g., entrance conduits, splice cases, protectors). The equipment room may also serve as a telecommunications room (containing a horizontal cross-connect). In addition to its communications function, the equipment room may also serve audio/video and security equipment.

E. Each building may contain one or more telecommunications rooms. Telecommunications rooms contain the horizontal cross-connect for optical fiber and copper twisted-pair as well as electronics (e.g., Ethernet switches). In addition to its communications function, the equipment room may also serve security equipment.

F. Function

1. Communications rooms provide an environmentally suitable and secure area for communications and security equipment, including: cross-connects, interconnects, backbone terminations, horizontal cable terminations and electronic equipment. They may also be used to house audio/video equipment and terminations.

2. Communications rooms shall house only equipment directly related to the telecommunications systems, including audio/video and security systems and, as required, the room’s environmental support systems.

3. An equipment room may include the functions of a telecommunications room, entrance room, or both.
Communications Equipment Room Fittings

G. Location
1. Communications rooms shall be located as close as practicable to the center of the area being served.
2. Communications rooms shall be located so they are not restricted by building components that limit expansion (e.g., elevators, core, outside walls, fixed building walls).
3. Communications rooms shall be located so as not to be a flood threat. For example, locations that are below or adjacent to areas of potential water hazard (e.g., restrooms and kitchens) shall be avoided. Additionally, areas having floor drains shall be avoided.
4. Communications rooms shall be located away from sources of electromagnetic interference (e.g., electrical power supply transformers, motors, generators, x-ray/MRI equipment radio or radar transmitters).
5. Equipment rooms shall be located as close as practicable to the electrical entrance.
6. Equipment rooms shall be located to allow delivery of large equipment.

H. Access
1. Communications rooms shall be located in an accessible area (e.g., hallway).
2. Communications rooms shall be keyed to the university’s standard for telecom rooms.
3. Communications rooms shall be fitted with card reader access control. The card read shall control a fail secure electrified lock with integral request to exit switch in the handle.

I. Size
1. Communications rooms shall accommodate 3-feet of work space between electrical components (e.g., back of a switch to the front of the security equipment; front of rack to telephone terminations).
2. Communications rooms shall accommodate 12 in wide vertical wire management between and at the ends of the equipment racks.
3. Communications rooms shall accommodate three (3) 4RU horizontal wire management per equipment rack.
4. Communications rooms shall accommodate rack mounted angled patch panels for three telecommunications receptacles (i.e., RJ-45) for every 100 square feet of floor area served by the communications room.
5. Communications rooms shall accommodate separate rack mounted angled patch panels for a wireless access point receptacle (i.e., RJ-45) located at every building column that is served by the communications room.
6. Communications rooms shall accommodate separate rack mounted angled patch panels, as necessary, for two elevator receptacles (i.e., RJ-45) per elevator controller, for two security receptacles (i.e., RJ-45) per security controller, and for two building automation system receptacles (i.e., RJ-45) per machine room controller that is served by the communications room.
7. Each telecommunications room shall accommodate wall terminated (e.g., 110 termination blocks) category 3 twisted-pair backbone cabling for a minimum of
one pair per 100 square feet served (rounded up to the nearest 100-pair complement).

8. Equipment rooms shall accommodate wall terminated (e.g., 110 termination blocks) category 3 twisted-pair backbone cabling for a minimum of backbone twisted-pairs serving each telecommunications room.

9. Communications rooms shall accommodate separate rack mounted angled patch panels and wall terminated (e.g., 110 termination blocks) twisted-pair cross-over cabling (category 3) sized at 4-pair per 200 square feet (one RJ-45-port per 200 square feet) served by the communications room.

10. Communications rooms shall accommodate sufficient 188B2 cross-connect wire management for wall mounted terminations (e.g., between backbone 110 terminations and cross-over 110 terminations).

11. Each telecommunications room shall accommodate two (2) rack mounted, 4RU high fiber distribution patch panels for optical fiber building backbone cabling (i.e., OS2 single-mode, OM4 multimode).

12. Equipment rooms shall accommodate two (2) rack mounted, 4RU high fiber distribution patch panel per telecommunication room served plus two 4RU fiber distribution patch panel for building entrance (i.e., OS2 single-mode, OM1 multimode).

13. Each telecommunications room shall accommodate a minimum of 6-feet wide by 8-feet high wall space for security equipment.

14. Equipment rooms shall accommodate a minimum of 8-feet wide by 8-feet high wall space for security equipment.

15. Each telecommunications room shall accommodate a minimum of one wall mounted rack for audio/video equipment.

16. Equipment rooms shall accommodate a minimum of two wall mounted racks for audio/video equipment.

J. Interior provisioning

1. Equipment not related to the support of the communications room (e.g., piping, ductwork, pneumatic tubing) shall not be installed in, pass through, or enter a communications room. With exception of piping for fire sprinklers, all pipes shall be routed around communications rooms.

2. Communications rooms shall have void-free ¾” AC grade, fire-resistant plywood backboards shall be installed (smooth side to the room interior) on the perimeter walls over the gypsum board mounted 12” AFF. All seams shall be sealed.

3. Plywood backboards within communications rooms shall be painted with a white, fire-retardant paint with exception of the written area on the plywood indicating that it is fire-retardant.

4. Communications room walls shall extend from floor slab to ceiling deck with no drop ceilings. The minimum walls height shall be 10’-0”.

5. Communications room floors shall be sealed and tiled with anti-static tile.
6. Equipment rooms shall have a minimum 6'W X 6'-8"H door (double door) without a door threshold and without windows. The door should open towards the outside of the room. Hinges shall be pinned with anti-pry guards.

7. Telecommunications rooms shall have a minimum 3'W X 6'-8"H door without a door threshold and without windows. The door should open towards the outside of the room. Hinges shall be pinned with anti-pry guards.

8. A slot or slots shall be installed to accommodate cable runway entry from a corridor and a UL approved fire rated assembly. The formed slot shall not have burrs or sharp edges.

9. Floor sleeves or slots should be located adjacent to the door. Sleeves and slots shall extend 1-3 inches AFF and be firestopped at all times except during cable installation.

10. Communications rooms shall be located on floor areas designed with a minimum floor loading of 50 lb/ft²).

K. Fire protection

1. Each communications room shall be equipped with fire detection, fire-extinguishing system and prevention devices. The fire detection devices shall be installed to the building fire alarm system. A minimum of one smoke detector shall be installed in each communications room.

2. It’s preferable that the fire sprinkler system for the communications rooms be a dry, pre-action system. Wire cages shall be installed on all sprinkler heads within the room. The location of the sprinkler heads shall be positioned so that it is not over equipment. Where sprinkler heads are positioned over equipment, drainage troughs shall be installed to protect electronic equipment from leakage.

L. Electrical

1. Communications rooms shall contain their own power panel for circuits specific to the equipment within that room.

2. Communications room lighting circuits shall be fed from a power panel other than from within the communications room.

3. Communications room lighting shall be an integrated switch/sensor control that is located at the entrance of the room. Additional sensors may be required to sense that the room is occupied.

4. Communications room illumination shall be uniform throughout the room at a minimum of 500 lux (50 foot candles) measure 3’ AFF in all aisles between cabinets and racks. Luminares shall be installed at a minimum height of 9’-0” AFF and in the middle of all aisles between cabinets and racks.

5. Communications rooms shall have emergency lighting and signs installed such that the absence of primary lighting will not hamper emergency exit.

6. Communications rooms shall have a wall phone location near the entry door. The wall phone location shall consist of an 4-11/16” x 4-11/16” x 2-1/8” electrical box with a single gang mud-ring (flush with face of plywood) and a 1” (minimum) conduit stubbed to the ladder rack.

7. Electrical feeders/branch circuits shall not be placed or run through any communications room, except as required to service those rooms.
8. Each equipment rack within a communications room shall have one dedicated 20A 120V NEMA 5-20R duplex outlet mounted 6” AFF, placed to the rear of the vertical management, facing to the rear.

9. Each equipment rack within a communications room shall have one dedicated 30A 208V NEMA L6-30R outlet mounted 6” to 12” AFF, placed to the rear of the vertical management, facing to the rear.

10. The first equipment rack in each communications room shall have one additional 30A 208V NEMA L6-30R outlet on the building’s emergency power to support the gateway/router and facility network equipment.

11. Security equipment shall have two dedicated 20A 120V NEMA 5-20R duplex outlets on the building’s emergency power mounted 6” AFF. All power circuits specific to security equipment shall also be on the building’s emergency power; additional circuits may be necessary – coordinate with security system designer and ITS as necessary.

12. The perimeter of the communications room shall have convenience 20A 120V NEMA 5-20R duplex outlets mounted 6” AFF at 6 feet intervals around perimeter walls.


M. Temperature and humidity

1. HVAC shall be included to maintain the equipment within the room. The HVAC shall be continuous (24 hours per day and 365 days per year). Where a standby (emergency) power source is available, the HVAC system serving the room should be connected to the standby (emergency) supply.

2. Temperature: 60-degrees to 78-degrees Fahrenheit

3. Humidity (non-condensing): 30-percent to 50-percent

4. Sensors shall be installed in communications rooms to monitor temperature and humidity.

5. A positive pressure shall be maintained with a minimum of one air change per hour.

6. The room shall be protected from contaminants and pollutants that could affect electronic equipment.

N. A shallow room shall be provided for cable pass-through between floors when a telecommunications room is not necessary (e.g., a room not being needed due to cable length limitations). This shallow room should be a minimum of 24 inches deep by 4 feet wide with sleeves and a 36” doorway, plywood back-board and cable ladder.

PART 2 - PRODUCTS

A. General

1. Refer to other Division 27 specifications for product and additional information.

B. Plywood backboard

1. Shall be 4 x 8 x ¾” A/C, fire rated plywood.

2. Shall be painted – white, acrylic, interior, fire-retardant paint.

PART 3 - EXECUTION
A. Notify Design Engineer and ITS Representative in writing as soon as possible of any discrepancies between communications room design (on drawings) and these specifications.

B. Backboards

1. Linear wall space used for anchoring equipment shall be lined for the full closet width with fire treated BCX grade exterior plywood 3/4” and 8’ high.

2. Plywood for mounting termination equipment on shall be installed vertically side by side 12” above finished floor. Mounting of plywood shall be sufficient enough to support the equipment.

3. Plywood for supporting riser cables shall be installed vertically resting directly on the finished floor. Anchoring and mounting techniques of plywood used to support backbone riser cables shall be sufficient to support a minimum of 1500 pounds of weight.

4. In no cases shall the heads of mounting screws protrude past the face of the plywood.

END OF SECTION

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SECTION 27 11 13
COMMUNICATIONS ENTRANCE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY
   A. Provide all labor, materials, tools, and equipment required mounting communications
cabling entrance protection.

1.2 RELATED DOCUMENTS
   A. The following codes shall be followed as required by law:
      1. ANSI/NFPA-70, National Electric Code
   B. The following standards shall be followed:
      1. ANSI/TIA-568C.
      2. ANSI/TIA569C
      3. ANSI/TIA758-B
      4. ANSI/TIA/EIA-606-A
      5. ANSI-J-607-A
      6. UL 497, 497A, 1449
   C. The following guidelines shall be followed:
      1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
      2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 QUALITY ASSURANCE
   1. Listed materials (by Nationally Recognized Testing Laboratory)

PART 2 – PRODUCTS

2.1 BUILDING ENTRANCE TERMINALS (BET)
   A. Wall mountable.
   B. Populated with factory-installed and tested 5-pin 3-element gas tube protector unit.
   C. Protectors shall be UL listed.
   D. Shall have external ground lug for building ground or connecting additional protectors.
   E. Refer to drawings for location, quantity and type (shape) of entrance terminals.
   F. Manufacturer shall be one of the following:
      1. Circa
      2. ITW Linx
      3. Porta Systems

2.2 4-PAIR BUILDING ENTRANCE PROTECTOR
A. For all applications where a single voice/data/security 4-pair category cable serves an outlet outside the footprint of the building (ie, an emergency telephone, exterior wireless access point, or exterior IP Security camera).

B. 110 Termination

C. Shall be certified up to category 6 cable performance to the performance of the cable, up to Category 6A, including power-over-ethernet applications.

D. Shall contain Solid State modules.

E. Protectors shall be UL listed.

F. Manufacturer shall be Acceptable manufacturers:
   1. ITW Linx, CAT6-75
   2. Porta Systems, 606-65
   2.3. Approved equivalent

PART 3 - EXECUTION

3.1 BUILDING ENTRANCE TERMINALS

A. Mount BET on wall surface in a manner sufficient to support the weight and to sustain incidental contact.

B. Field-verify actual length required for the input and output stubs.

C. Install grounding wire as straight as possible from terminal to Telecommunications Main Grounding Busbar (TMGB)/Telecommunications Grounding Busbar (TGB).

3.2 4-PAIR BUILDING ENTRANCE PROTECTOR

A. Where conduit for exterior outlets stubs into Communications Room, locate protector on plywood backboard. Label protector with outlet identifier.

B. Where conduit for exterior outlets stubs into building in a place other than in a Communications Room, install protector into an appropriately-sized junction box for physical protection. Label junction box with “ENTRANCE PROTECTION FOR EXTERIOR COMMUNICATIONS OUTLETS” and outlet identifier(s).
   1. Identify this location on Record Drawings.

3.3 GROUNDING AND BONDING

A. Where protector is located in Communications Room, bond protector to TMGB/TGB with #6 AWG copper ground wire.

B. Where protector is not located in Communications Room, bond protector to Telecommunications grounding system. Refer to Section 27 05 26 Grounding and Bonding for Communications, referenced standards and manufacturer instructions for additional information and requirements.

END OF SECTION
SECTION 27 11 19
COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 SUMMARY
A. This section specifies the products and installation of communications termination blocks and patch panels for copper twisted-pair and optical fiber cables.
B. The product performance (e.g., category 5e, category 6A, OM4, OS2) shall be as specified on drawings.

1.2 RELATED DOCUMENTS
A. The latest editions of the following codes, standards, and guidelines shall be followed. Bring to ITS' immediate attention where construction documents or conditions differ from the requirements in codes, standards, guidelines or specifications.
B. The following codes, as required by law
   1. ANSI/NFPA-70, National Electrical Code® (NEC®)
C. The following standards
   1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
   2. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
   3. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard
   4. ANSI/TIA-569-C, Telecommunications Pathways and Spaces
   5. ANSI/TIA-606-B, Administration Standard for the Telecommunications Infrastructure
   6. ANSI/TIA-607-B, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
D. The following guidelines
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
E. The following project specifications
   1. 27 05 26 Grounding and Bonding for Communications
   2. 27 05 53 Identification for Communications Systems
   3. 27 11 13 Communications Optical Fiber Backbone Cabling
   4. 27 15 13 Communications Copper Horizontal Cable
   5. 27 15 43 Communications Faceplates and Modular Jacks

1.3 QUALITY ASSURANCE
A. Termination blocks and patch panels shall be covered by the Advanced System Warranty (Refer to Section 27 00 00).
1.4 SUBMITTALS

A. All submittals that are incomplete shall be returned without review.

B. The following submittals shall be provided at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00, Communications. UT ITS shall have final approval of products for the installation.

1. Product Information
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
   b) Provide manufacturer’s product information showing system performance is maintained when using a variety of modular jacks (e.g., wall, patch panel), cable and patch cords (be manufacturer and product specific).
   c) All product information shall be provided at one time, in one submittal package.

2. Shop Drawings
   a) Provide scaled drawings (not less than 1/8” = 1'-0") indicating location and type/part number of product to be installed. Additionally, provide (1/4" = 1'-0" scale or greater) drawing elevations for equipment cabinets, racks, frames, enclosures and wall terminations indicating locations of terminal blocks and patch panels.

C. The following submittals shall be provided three (3) weeks prior to Substantial Completion, in accordance with the submittal requirements in Section 27 00 00, Communications.

1. Record Drawings
   a) Provide scaled drawings (not less than 1/8" = 1'-0") indicating location and type/part number of product to be installed. Additionally, provide (1/4" = 1'-0" scale or greater) drawing elevations for equipment cabinets, racks, frames, enclosures and wall terminations indicating installed locations of wall termination blocks and patch panels.
   b) All record drawings shall be provided at one time, in one submittal package.

2. Manufacturer and Maintenance Manuals for installed equipment.

PART 2 – PRODUCTS

2.1 GENERAL

A. All connectivity components either for copper or fiber (e.g., patch panels, modular jacks, optical fiber enclosures) shall be by the same manufacturer and covered under the same manufacturer Advanced System Warranty.

2.2 COPPER BALANCED TWISTED-PAIR

A. Wall-mounted 110-termination blocks and connectors (e.g., copper backbone termination, wall-to-rack termination)

1. Performance shall meet the performance requirements of ANSI/TIA 568-C.2.
2. Manufacturer shall be
   a) Panduit
   b) Ortronics
   c) or equivalent

B. Angled patch panels
   1. Size as identified on the drawings. Typical size is 48-port, 2RU.
   2. Shall accept modular jacks that meet the required performance of the specified category system.
   3. Manufacturer shall be
      1) Panduit – Mini-Com opening(s)
      2) Ortronics – TracJack opening(s)
      3) or equivalent

C. (Straight; flat) patch panels
   1. Specifications are the same as angled patch panels
   2. To be used where appropriate, such as for wall racks and enclosed cabinets.
      a) Manufacturer shall be
         1) Panduit – Mini-Com opening(s)
         2) Ortronics – TracJack opening(s)
         3) or equivalent

2.3 FIBER

A. Rack-mounted Fiber Enclosures
   1. Shall be 4RU in height and fit into a standard 19" wide rack.
      a) Refer to drawings for location.
   2. Shall have a front cover that swings down. Labeling shall be integrated either on the fiber enclosure cover or on the fiber adapter panels.
   3. Shall have a minimum capacity of 144-strands.
   4. Shall include fixtures to maintain the cable and optical fiber manufacturer’s minimum bend radius.
   5. Shall include a splice tray option.
   6. Manufacturer shall be
      a) Corning, Pretium Connector Housings (PCH)
         1) Include Splice Tray Bracket, Strain Relief Bracket, (12) Splice Trays Type 2S
      b) Systimax, 360 Modular Fiber Shelf
         1) Include (2) Fusion Splice Wallet (Tray) Kits
      c) Panduit, FCE4U
         1) Include FOSMM Fusion Splice Trays
B. Fiber Adapter Panel
   d) or equivalent

1. Shall fit into specified fiber enclosures.
2. Shall be in multiples of 12 strands.
3. Singlemode fiber adapters shall be LC/APC (green in color)
4. Multimode fiber cassettes shall be LC/UPC to MTP. The LC/UPC adapters shall be aqua in color.
5. Multimode fiber adapter panels shall have the adapters be aqua in color.
7. Manufacturer shall be
   a) Corning
   b) Systimax
   c) Panduit
   d) or equivalent

PART 3 - EXECUTION

3.1 GENERAL

A. Termination block and patch panel installation (copper and optical fiber) shall be in conformance to ANSI/TIA-568 standards, BICSI methods, industry standards and manufacturer’s instructions and guidelines.

B. Termination blocks and patch panels terminated in areas prior to final cleaning (e.g., painting, carpet installation, where dust may be created) shall be protected to ensure dust, debris, moisture and other foreign materials do not settle onto contacts or optical fiber end-faces.

C. Cables shall be terminated in consistent consecutive order.

D. Coordinate with all other trades prior to pre-construction submittals and installation.

E. Quantity on drawings is illustrative. Provide the quantity of wall-termination blocks and connectors, patch panels, enclosures and inserts to support the necessary quantity of cable pairs and strands plus 10%.

3.2 COPPER BALANCED TWISTED-PAIR

A. Follow 27 15 43 Communications Faceplates and Modular Jacks for terminations.

B. Cables shall be supported and loosely tied off by means of a strain relief bar on the back of patch panels.

C. Contractor shall terminate copper backbone (riser) cables onto wall-mounted 110 termination blocks using C-5 connectors.

D. Wall-to-rack cables shall be terminated between the backbone 110 termination field and patch panel(s). The wall-to-rack cables shall be 100 pair category 3. The 110 termination block shall be terminated with five (5) C4 connectors and one (1) C5 connector per 25-pair row. Four pair per port shall be terminated on the patch panels.
E. Provide a separate patch panel(s) in each Communications Room for Wireless Access Points.
F. Provide a separate patch panel(s) in each Communications Room for Building Automation Controls, Security and Elevators, and wall-to-rack copper backbone.

3.3 FIBER
A. Follow 27 13 23 Communications Optical Fiber Backbone Cabling for terminations.
B. The contractor shall furnish and install separate fiber enclosures for single-mode and multimode optical fiber in-building cables.
C. The contractor shall furnish and install LC/APC adapter panels (12-fibers per adapter panel) in each single-mode fiber enclosure.
D. The contractor shall furnish and install LC/UPC to MTP cassettes (12-fibers per cassette) for the installed multimode cable and LC/UPC adapter panels (12-fibers per adapter panel) for non-cassette spaces in each multimode fiber enclosure.

END OF SECTION
SECTION 27 13 23
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of optical fiber (single-mode and multimode).

1.2 RELATED DOCUMENTS

A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.

B. The following codes, as required by law:

1. National Electric Code (NEC)

C. The following standards:

1. TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
2. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
4. ANSI/TIA/EIA-604-10A, FOCIS 10, Fiber Optic Connector Intermatability Standard – Type LC
5. TIA-492AAAD, Detail Specification for 850-μm Laser-Optimized, 50-μm Core Diameter/125-μm Cladding Diameter Class la Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber
6. ANSI/TIA-758-A, Customer-Owned Outside Plant Telecommunications Infrastructure Standard
7. ANSI/TIA/EIA-455-1-B-2003, Cable Flexing for Fiber Optic Interconnecting Devices
9. ANSI/TIA/EIA-455-4-C-2002, Fiber Optic Component Temperature Life Test
10. ANSI/TIA/EIA-455-5-C-2002, Humidity Test Procedure for Fiber Optic Components
11. TIA-455-6-B-2003, Cable Retention Test Procedure for Fiber Optic Cable Interconnecting Devices
12. ANSI/TIA/EIA-455-8-2000, Measurement of Splice or Connector Loss and Reflectance Using an OTDR
21. TIA-492CAAB-2005, Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical Fibers With Low Water Peak
22. TIA 472C000-B/ICEA S-83-596-2001, Fiber Optic Premises Distribution Cable
23. TIA 472D000-B/ICEA S-87-640-1999, Fiber Optic Outside Plant Communications Cable
24. TIA 472E000/ICEA S-104-696-2003, Standard For Indoor-Outdoor Optical Cable

D. The following guidelines:
1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

E. The following project specifications:
1. 27 05 53 Identification for Communications Systems

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
1. Product Information
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
2. Shop Drawings
   a) Provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and type of pathway, including all pull points (to include pullboxes, communications LB, etc.). These locations are to be fully coordinated with all other trades.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
1. Record Drawings
a) Provide scaled drawings (not less than 1/8” = 1’-0”) indicating actual installed routing of fiber and type/locations of all pathways and pull points. Design or shop drawings modified in the field will not be accepted.

2. Manufacturer and Maintenance Manuals for all installed equipment

1.4 QUALITY ASSURANCE

A. All backbone optical fiber cable installation shall be performed in a neat and workmanlike manner.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to the approval of The University of Texas at Austin Design and Planning Department on submittals provided.

C. Trained technicians who have successfully attended an optical fiber training program, which have obtained a certificate as proof their installation knowledge shall install the backbone optical fiber cabling. Proof of optical fiber training shall be carried by the technician while performing any work. If proof is not provided on site, the technician may be excused from the site at no cost to the University. These certificates may have been issued by any of the following organizations or an equivalent organization:
   1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.
   2. Training organizations (e.g., BICSI, A Telecommunications Association).

1.5 DEFINITIONS

A. FDU – Fiber distribution unit. A rack-mounted fiber housing unit.

PART 2 – PRODUCTS

2.1 CABLE

A. The Advanced System Warranty as required by Section 27 00 00 shall govern cable manufacturer selection.

B. Indoor/outdoor cable shall include a water-blocking material.

C. Meet the environmental requirements for the area into which it is placed. For example, cabling placed in plenum space shall be listed as OFNP.

D. Optical fibers shall be industry-standard color coded in accordance with ANSI/TIA-598-C

E. Singlemode Fiber
   1. Singlemode cable shall:
      a) Meet OS2 fiber requirements (TIA-492CAAB-2005, Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical Fibers With Low Water Peak)
      b) Indoor cable shall have a sheath color of yellow
      c) Armored cables shall be used.
d) Acceptable manufacturers (who shall also provide the Advanced System Warranty):
   1) Corning
   2) Hitachi
   3) Mohawk
   4) Superior Essex
   5) Systimax

F. Multi-mode Fiber
   1. Multimode cable shall:
      a) Meet OM4 fiber requirements (TIA-492AAAD, Detail Specification for 850-μm Laser-Optimized, 50-μm Core Diameter/125-μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber)
      b) Indoor cable shall have a sheath color of aqua.
      c) Fibers shall be pre-terminated with MTP connectors (12-fibers per MTP connector) on each end of the fiber cable.
      d) Method “B” shall be used for installation and maintaining optical fiber polarity (see ANSI/TIA-568-C.0).
      e) Meet the environmental requirements for the area into which it is placed. For example, cabling placed in plenum space shall be listed as OFNP.
      f) Armored cables shall be used.
      g) Acceptable manufacturers (who shall also provide the Advanced System Warranty):
         1) Corning
         2) Hitachi
         3) Mohawk
         4) Superior Essex
         5) Systimax

PART 3 - EXECUTION
3.1 GENERAL
   A. Provide all labor, materials, tools and equipment required for the complete and proper installation of backbone optical fiber cabling.
   B. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the backbone optical fiber cabling installation with other applicable trades.
   C. All backbone optical fiber cabling shall be installed point-to-point (e.g., equipment room to telecommunications room) without splice points other than a fusion splice of the single-mode pigtails
D. Each cable type shall be terminated in its own 4U high fiber distribution unit (FDU). A maximum of 144 fibers per 4U FDU shall be permissible. For example, up to 144 50/125µm (OM4) fibers shall terminate in its own FDU per telecommunications room.

E. Single-mode (OS2) cabling shall be used.
   1. Fusion splice pigtails (LC/APC) shall be used for terminating the cable and inserted in LC/APC single-mode adapters.
   2. Polarity shall be maintained using consecutive-fiber positioning (see ANSI/TIA-568-C.0)

F. Multi-mode (OM4) cabling shall be used.
   1. Multi-mode (OM4) cable shall be ordered pre-terminated with 12-fiber MTP connectors on each end. The MTP connectors shall plug into transitions (cassettes) having LC/UPC connectors on the front of the FDU.
   2. Polarity shall be maintained using Method B for array connectors (see ANSI/TIA-568-C.0).

G. Follow all manufacturers’ instructions.

H. Coordinate with all other trades prior to installation.

END OF SECTION
SECTION 27 15 13
COMMUNICATIONS COPPER HORIZONTAL CABLE

PART 1 - GENERAL

1.1 SUMMARY
A. This section shall govern the products and installation of category copper horizontal cable.
B. The cable performance (category 5e, category 6A) shall be as specified on drawings and confirmed with UT ITS-N&T, Facilities Design.

1.2 RELATED DOCUMENTS
A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines or specifications.
B. The following codes, as required by law:
   1. National Electrical Code® (NEC®)
C. The following standards:
   1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
   2. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
   3. ANSI/TIA-569-C, Telecommunications Pathways and Spaces
D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
E. The following project specifications:
   1. 27 05 26 Grounding and Bonding for Communications
   2. 27 05 37 Firestopping Systems for Communications Cabling
   3. 27 05 53 Identification for Communications Systems
   4. 27 08 20 Copper Testing
   5. 27 11 19 Communications Terminations Blocks and Patch Panels
   6. 27 15 43 Communications Faceplates and Modular Jacks
   7. 27 16 19 Communications Patch Cords, Station Cords and Cross Connect Wires

1.3 SUBMITTALS
A. The following submittals shall be provided at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. All submittals that are incomplete shall be returned without review.
   2. Product Information
a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.

b) Provide manufacturer’s product information showing system performance is maintained when using a variety of modular jacks (wall, patch panel) and patch cords (be manufacturer and product specific).

3. Shop Drawings
   a) Provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of copper horizontal cabling.

B. The following submittals shall be provided three (3) weeks prior to Substantial Completion, in accordance with the submittal requirements in Section 27 00 00 Communications:
   1. Record Drawings
      a) Provide scaled drawings (not less than 1/8" = 1'-0") indicating actual installed routing of copper horizontal cable. Design or shop drawings modified in the field shall not be accepted.
   2. Manufacturer and Maintenance Manuals for all installed equipment.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS
   A. The Contractor shall utilize a single manufacturer brand for copper horizontal cable.

2.2 BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLE
   A. Cable shall be balanced twisted-pair, four-pair, unshielded, with an overall jacket.
   B. Cable performance shall meet the performance of ANSI/TIA-568-C.2.
   C. Cable shall be listed by a Nationally Recognized Testing Laboratory (NRTL).
   D. Cable installed in buildings shall be CMP listed per the NEC (Article 800).
   E. Un-listed cable shall only be permitted for entrance to a building and be limited to 50 feet (see NEC Article 800).
   F. Cable sheath shall be blue with white or black lettering. Wet-rated cable sheath shall be black with white lettering. The lettering (marking) shall indicate the following:
      1. Manufacturer name
      2. Pair count
      3. American Wire Gauge (AWG)
      4. Listing
      5. Performance rating (e.g., category 5e, category 6A)
      6. Sequential length markings, in one foot increments
   G. Cable manufacturers
      1. Belden
      2. Berk-Tek
      3. Commscope
4. General Cable
5. Mohawk
6. Panduit
7. Superior Essex
8. Approved equivalent

PART 3 - EXECUTION

3.1 GENERAL

A. Copper horizontal cable shall have its own support structure. Support all horizontal cable continuously (e.g., conduit, cable tray) or a maximum of every 5 feet with j-hooks. Cable shall not contact suspended ceiling and should be installed such that it is a minimum of 6 inches above any portion of the suspended ceiling. The suspended ceiling nor the suspended ceiling support wire shall be used to support cable.

B. Cable shall be installed in a continuous length from communications room to outlet.

C. The maximum installed cable length (physical length) shall be 295 feet.

D. Cable installation shall be in conformance to ANSI/TIA-568 standards, BICSI methods, industry standards and manufacturer’s installation guidelines.

E. Cable installation shall not exceed 25 lbf pulling tension.

F. Cable installation shall not exceed a cable bend radius of 4-times the cable diameter while under load or no-load conditions.

G. Provide at the communications room a minimum of 6 feet of service loop that is dressed on the cable tray above the termination point (typically within the cable tray).

H. Provide a minimum of 36 inches of cable for service loop above the drop location for the outlet location. Service loops shall be 12 to 18 inches in diameter.

I. Modular furniture cables shall terminate within the modular furniture and shall have a minimum of 36 inches of cable for service loop above the drop location. Service loops shall be 12 to 18 inches in diameter.

J. Cable shall be installed with a minimum separation from EMI sources:
   1. 6 inches from power lines enclosed in a grounded metal conduit.
   2. 6 inches from fluorescent light fixtures
   3. 48 inches from electrical motors or transformers.

K. Coordinate pathways and installation with all other trades prior to installation.

L. Lubrication shall not be used on cable.

M. The cable shall not be painted for any length. Cable that is painted shall be replaced at no cost to the owner/project.

N. All copper horizontal cabling shall be tested in accordance with section 27 08 20 Copper Testing.

O. For outside-plant cables to be installed as part of the contract documents that are not listed, provide a transition point and enclosure in an accessible location for transition listed to un-listed cable.

1. Indicate the transition location on the Record Drawings.
END OF SECTION
SECTION 27 15 43
COMMUNICATIONS FACEPLATES AND MODULAR JACKS

PART 1 - GENERAL

1.1 SUMMARY
A. This section shall govern the products and installation of communications faceplates and modular jacks.
B. The product performance (e.g., category 5e, category 6A) shall be as specified on drawings.

1.2 RELATED DOCUMENTS
A. The latest editions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from the requirements in codes, standards, guidelines or specifications.
B. The following codes, as required by law:
   1. National Electrical Code® (NEC®)
C. The following standards:
   1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
   2. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
   3. ANSI/TIA-570-C, Residential Telecommunications Infrastructure Standard
   4. ANSI/TIA-569-C, Telecommunications Pathways and Spaces
D. The following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
E. The following project specifications:
   1. 27 05 33, Conduits and Backboxes for Communications Systems
   2. 27 05 39, Surface Raceways for Communications Systems
   3. 27 05 53, Identification for Communications Systems

1.3 SUBMITTALS
A. The following submittals shall be provided at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00, Communications. UT ITS shall have final approval of products for the installation.
   1. Product Information
      a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
      b) Provide manufacturer’s product information showing system performance is maintained when using a variety of modular jacks (e.g., wall, patch panel), cable and patch cords (be manufacturer and product specific).
2. **Shop Drawings**
   a) Provide scaled drawings (not less than 1/8" = 1'-0") indicating location and type/part number of faceplate and modular jack to be used. This information may be included on shop drawing for 27 05 53, Identification of Communications Systems.

B. The following submittals shall be provided three (3) weeks prior to Substantial Completion, in accordance with the submittal requirements in Section 27 00 00 Communications:
   1. **Record Drawings**
      a) Provide scaled drawings (not less than 1/8" = 1'-0") indicating location and type/part number of faceplate and modular jack installed. Design or shop drawings modified in the field shall not be accepted. This information may be included on record drawing for 27 05 53 Identification of Communications Systems.
      b) Manufacturer and Maintenance Manuals for installed equipment.
      c) All submittals that are incomplete shall be returned without review.

**PART 2 – PRODUCTS**

2.1 **GENERAL**
   A. Faceplates and modular jacks shall be by the same manufacturer except as noted on drawings and this specification. This manufacturer shall be the same manufacturer that supplies the manufacturer advanced system warranty as required by Section 27 00 00.

2.2 **FACEPLATE**
   A. Wall-phone outlet
      1. Shall be single-gang.
      2. Shall be stainless steel.
      3. Shall meet the dimensional requirements for faceplate and modular jack as specified in ANSI/TIA-570-C.
      6. Coordinate with owner prior to purchase.
      7. Manufacturer shall be:
         a) Allen-Tel AT630B-8
         b) or equivalent
   B. Typical work-area outlets:
      1. Single-Gang Faceplate
         a) Color and material shall meet requirements for environment and match electrical faceplates.
         b) Shall have a recessed label field with high impact thermo-plastic cover.
         c) Manufacturer shall be:
1) Panduit – Mini-Com opening(s)
2) Ortronics – TracJack opening(s)
3) or equivalent

2. Double-Gang Faceplate
   a) Color and material shall meet requirements for environment and match
electrical faceplates.
   b) Shall have a recessed label field with high impact thermo-plastic cover.
   c) Manufacturer shall be:
      1) Panduit – Mini-Com opening(s)
      2) Ortronics – TracJack opening(s)
      3) or equivalent

C. Above-ceiling outlets for wireless access points:
   1. Single-Gang Faceplate
      a) Shall be stainless steel in construction.
      b) Manufacturer shall be:
         1) Panduit – Mini-Com opening(s)
         2) Ortronics – TracJack opening(s)
         3) or equivalent

2.3 MODULAR JACK (INCLUDING SURFACE-MOUNT)
A. Category modular jacks
   1. Performance shall meet that of ANSI/TIA-568-C.2.
   2. Color and material shall meet requirements for environment and match
electrical faceplates.
   3. Manufacturer shall be:
      a) Panduit – Mini-Com
      b) Ortronics – TracJack
      c) or equivalent

PART 3 - EXECUTION
3.1 GENERAL
   A. Follow all manufacturers’ instructions.
   B. Faceplates and modular jack installation shall be in conformance to ANSI/TIA-568
      standards, BICSI methods, industry standards and manufacturer’s guidelines.
   C. Coordinate with all other trades prior to pre-construction submittals and installation.

3.2 FACEPLATE
   A. Faceplates shall be installed straight and plumb in all directions.
   B. Faceplates shall be installed with screws.
C. Should the faceplate not cover the entirety of the outlet box hole in the wall due to overcutting or rough workmanship, the wall shall be appropriately patched and painted for a neat and clean finished appearance.

D. Fill all module openings with blank modules.

3.3 MODULAR JACK (INCLUDING SURFACE-MOUNT)

A. All category modular jacks shall be terminated using the T568B termination scheme specified in ANSI/TIA-568-C.0.

B. Modular jacks terminated in areas prior to final cleaning (e.g., painting, carpet installation, dusty areas) shall be placed in a protective envelope to ensure dust, debris, moisture and other foreign materials do not settle onto modular jack contacts. Once final cleaning is complete, modular jacks shall be inserted into faceplates and screwed into place.

C. Pair-twist shall be maintained up to the point of termination.

D. Cable sheath shall be maintained up to within 0.5 inches of the modular jack termination.

3.4 ELEVATOR PHONE AND DATA CONNECTIONS

A. Inside Phone/Data Enclosure in the Elevator Equipment Room, typically identified as CCTV enclosure, install (1) double-gang faceplate onto surface-mounted box (refer to section 27 05 39). Populate faceplate with two modular jacks for every elevator car needing service.

END OF SECTION
SECTION 27 16 19
TELECOMMUNICATIONS PATCH CORDS, STATION CORDS, AND CROSS CONNECT WIRES

PART 1 - GENERAL

1.1 SUMMARY
A. This section specifies telecommunications patch cords (for use in telecommunications rooms), station cords (for use at work area outlets), and cross connect wire (for use in telecommunications rooms).

1. The contractor shall supply cross connect wire as part of a complete and functioning telecommunications system.

2. The contractor shall supply station cords (deliverable to UT ITS) for 100% of the installed work area outlet modular jacks that match the cabling performance (e.g., category 5e, category 6A, OM4, OS2).

3. The contractor shall supply patch cords (deliverable to UT ITS) for 100% of the installed modular jack ports in all contract-installed patch panels or modules (e.g., balanced twisted-pair and optical fiber) that match the cabling performance (e.g., category 5e, category 6A, OM4, OS2).

1.2 RELATED DOCUMENTS
A. The latest editions of the following codes, standards, and guidelines shall be followed. Bring to ITS’ immediate attention where construction documents or conditions differ from the requirements in codes, standards, guidelines or specifications.

B. The following codes, as required by law.

1. ANSI/NFPA-70, National Electrical Code® (NEC®)

C. The following standards.

1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises

2. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards

3. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard

4. ANSI/TIA-606-B, Administration Standard for the Telecommunications Infrastructure

D. The following guidelines.

1. BICSI, Telecommunications Distribution Methods Manual (TDMM)

2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

E. The following project specifications.

1. 27 05 53 Identification for Communications Systems

2. 27 11 13 Communications Optical Fiber Backbone Cabling

3. 27 11 19 Termination Blocks and Patch Panels

4. 27 15 13 Communications Copper Horizontal Cable

5. 27 15 43 Communications Faceplates and Modular Jacks
1.3 SUBMITTALS

A. The following submittals shall be provided at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications. UT ITS shall have final approval of products.

1. Product Information.
   a) Provide manufacturer’s product information cutsheet or specifications sheet with the specific product number identified or filled out.
   b) Provide manufacturer’s product information showing system performance is maintained when using a variety of modular jacks (e.g., wall, patch panel), cable and patch cords (be manufacturer and product specific).
   c) Provide spreadsheet (in Microsoft Excel format), indicated cord cable type (e.g., category, stranded), manufacturer, part number, and quantity of cords to be supplied to UT ITS.
   d) All submittals that are incomplete shall be returned without review.

PART 2 – PRODUCTS

2.1 GENERAL

A. Manufacturer shall be such that the advanced telecommunications system warranty shall be met.

B. Product shall adhere to matching the environment to which they are installed (e.g., plenum-rated cords for plenum spaces).

2.2 COPPER CROSS CONNECT WIRE

A. Provide one (1) 1000 ft spool of 24 AWG one-pair (twisted-pair) cross-connect wire for each equipment room and telecommunications room.

2.3 COPPER PATCH CORDS (FOR USE IN TELECOMMUNICATIONS ROOM [IDFS] AND EQUIPMENT ROOM [MDF])

A. Patch cords shall be four-pair, unshielded, balanced twisted-pair enveloped within a single jacket with factory-terminated RJ-45 plug-modules on each end.

B. Patch cords shall be equipped with snagless fixtures.

C. Cords shall meet the highest performance component of the cabling link (see ANSI/TIA-568-C.2).

D. The cord cable pairs shall meet the color code specified in ANSI/TIA-568-C.2 and ANSI/TIA-568-C.0.

E. The cord cable pairs shall be terminated to match the T568B wiring description in ANSI/TIA-568-C.0.

F. Length
   1. 30% of the patch cords for 100% of the installed patch panel ports shall be five (5) feet in length.
   2. 60% of the patch cords for 100% of the installed patch panel ports shall be seven (7) feet in length.
3. 10% of the patch cords for 100% of the installed patch panel ports shall be ten (10) feet in length.

G. Color
1. Patch cord sheath color shall be requested from UT ITS three (3) months prior to Substantial Completion.

H. Manufacturer shall be the same as copper connectivity manufacturer.
   1. Ortronics
   2. Panduit
   3. or equivalent

2.4 COPPER STATION CORDS (FOR USE AT WORK AREA OUTLETS)
A. Cords shall be four-pair, unshielded, balanced twisted-pair enveloped within a single jacket with factory-terminated RJ-45 plug-modules on each end.
B. Cords shall meet the highest performance component of the cabling link (see ANSI/TIA-568-C.2).
C. The cord cable pairs shall meet the color code specified in ANSI/TIA-568-C.2 and ANSI/TIA-568-C.0.
D. The cord cable pairs shall be terminated to match the T568B wiring description in ANSI/TIA-568-C.0.
E. Length
   1. 60% of the station cords for 100% of the installed modular jacks at the work area outlet shall be ten (10) feet in length.
   2. 25% of the station cords for 100% of the installed modular jacks at the work area outlet shall be fifteen (15) feet in length.
   3. 15% of the station cords for 100% of the installed modular jacks at the work area outlet shall be ten (20) feet in length.
F. Color
   1. Station cord sheath color shall be requested from UT ITS three (3) months prior to Substantial Completion.
G. Manufacturer shall be the same as copper connectivity manufacturer:
   1. Ortronics
   2. Panduit
   3. or equivalent

2.5 FIBER OPTIC PATCH CORDS
A. Single-mode
   1. Optical fiber patch cords shall be duplex.
   2. Optical fiber shall be single-mode; OS2 performance (see ANSI/TIA-568-C.3.
   3. Optical fiber glass type shall be bend insensitive.
   4. Connector shall be LC/APC on one end and LC/UPC on the other end.
   5. Minimum bend radius shall be 10mm.
6. Insertion Loss maximum shall be 0.2dB.
7. Return Loss maximum shall be -58dB.
8. Humidity range shall be 5 to 95% relative humidity.
9. End-face shall be Harden Lens Contact (HLC).
10. Length
    a) 30% of the patch cords for 100% of the installed patch panel ports shall be five (2) meters in length.
    b) 50% of the patch cords for 100% of the installed patch panel ports shall be seven (3) meters in length.
    c) 10% of the patch cords for 100% of the installed patch panel ports shall be ten (5) meters in length.
    d) 10% of the patch cords for 100% of the installed patch panel ports shall be ten (6) meters in length.
11. Color
    a) The duplex cord sheath shall be yellow.
    b) The LC/UPC connector strain relief and connector plug body shall be blue.
    c) The LC/APC connector strain relief and connector plug body shall be green.
12. Manufacturer shall be:
    a) Megladon
    b) Systimax
    c) Corning
    d) Panduit
    e) or equivalent

B. Multimode
1. Optical fiber patch cords shall be duplex.
2. Optical fiber shall be multimode; OM4 performance (see ANSI/TIA-568-C.3).
3. Optical fiber glass type shall be bend insensitive.
4. Connector shall be LC/UPC on one end and LC/UPC on the other end.
5. Minimum bend radius shall be 15mm.
6. Insertion Loss maximum shall be 0.2dB.
7. Return Loss maximum shall be -45dB.
8. Humidity range shall be 5 to 95% relative humidity.
9. End-face shall be Harden Lens Contact (HLC).
10. Length
    a) 30% of the patch cords for 100% of the installed patch panel ports shall be five (2) meters in length.
b) 50% of the patch cords for 100% of the installed patch panel ports shall be seven (3) meters in length.

c) 10% of the patch cords for 100% of the installed patch panel ports shall be ten (5) meters in length.

d) 10% of the patch cords for 100% of the installed patch panel ports shall be ten (6) meters in length.

11. Color

a) The duplex cord sheath shall be aqua.

b) The LC/UPC connector strain relief and connector plug body shall be aqua.

12. Manufacturer shall be:

a) Megladon

b) Systimax

c) Corning

d) Panduit

e) or equivalent

PART 3 - EXECUTION

2.1 GENERAL

A. Patch cords and wire shall be delivered one (1) month prior to Substantial Completion.

B. UT ITS shall be notified of patch cord and wire delivery.

2.2 COPPER CROSS CONNECTS

A. Provide one (1) 1000 foot reel of white/blue cross connect wire in each telecommunications room (IDF) and equipment room (MDF).

B. Provide one (1) 1000 foot reel of white/red cross connect wire in each telecommunications room (IDF) and equipment room (MDF).

2.3 COPPER PATCH CORDS (FOR USE IN TELECOMMUNICATIONS ROOM [IDFS] AND EQUIPMENT ROOM [MDF])

A. Patch cords shall be distributed among telecommunications rooms according to the number of patch panel ports in the telecommunications room or equipment room.

B. Each box of patch cords shall be marked to identify the use as being for patch panel use.

2.4 COPPER STATION CORDS (FOR USE AT WORK AREA OUTLETS)

A. Patch cords shall be distributed among telecommunications rooms according to the number of work area outlet ports fed by the telecommunications room or equipment room.

B. Each box of patch cords shall be marked to identify the use as being for work area outlet use.

2.5 FIBER OPTIC PATCH CORDS

A. Single-mode
1. Patch cords shall be distributed among telecommunications rooms according to the number of patch panel ports in the telecommunications room or equipment room.

2. Each box of patch cords shall be marked to identify the use as being for patch panel use.

B. Multimode

1. Patch cords shall be distributed among telecommunications rooms according to the number of patch panel ports in the telecommunications room or equipment room.

2. Each box of patch cords shall be marked to identify the use as being for patch panel use.

END OF SECTION
SECTION 27 21 33
DATA COMMUNICATIONS WI-FI ACCESS POINTS

PART 1 – GENERAL

1.1 SUMMARY
A. This section specifies requirements for the design/layout, and installation of communications data outlets that are to serve IEEE 802.11 wireless access points (WAPs).

1.2 DESIGN REQUIREMENTS
A. Coverage areas
1. All building spaces shall have coverage for currently supported Wi-Fi standards (as of 6/2012 this includes 802.11a/g/n at a minimum SNR of 25dBm, but will include 802.11ac as soon as equipment is provided by vendors).
2. Outdoor coverage around the exterior of the building shall be provided for all high-user areas and where practical in other areas.
   a) Outdoor wireless coverage may require building exterior wall penetration, the mounting of antennas on the building exterior and underground pathways to strategic WAP outdoor mounting locations such as emergency call boxes and signs.
   b) Coordinate with ITS during design for best indoor and outdoor locations.

B. Density of communication outlets for WAPs
1. Residence halls – one per 1600 gross square feet.
2. Other typical buildings – one per 2500 gross square feet.
3. Unique requirements
   a) For areas where high end-device density is anticipated, special consideration for wireless coverage shall be examined (see item 1.2, A., 2., b)).
      1) Generally, 25 end-devices (not persons) per WAP.
      2) As wireless technology rapidly evolves, changes to RF spectrum usage may trigger changes to WAP density and mounting.
   b) Auditoriums and large classrooms utilize applications requiring a high density of WAP coverage and also require special accommodations for WAP installations. The WAP density is driven by concurrent users sessions and bandwidth requirements in the space instead of area coverage. Close consultation with ITS is required.
      1) Estimate the following number of access points based on the occupancy in the following chart:

<table>
<thead>
<tr>
<th>Classroom/Auditorium Occupancy</th>
<th>Estimated number of WAPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 125</td>
<td>1 WAP / 25 people</td>
</tr>
</tbody>
</table>
2) Proper installation and mounting of WAPs in these spaces may result in WAPs with moderate to high visibility. Mounting above a hard deck ceiling or below a hard floor or in proximity to metal building components, HVAC ducts, etc. can diminish the wireless signal beyond the tolerances for a high-density deployment. Current deployments of WAPs in these types of spaces typically have WAPs visibly mounted to both the ceiling and underneath the classroom seating in box enclosures or from the walls.

3) Cabling pathways to ceiling mount WAP locations as well floor or wall locations must be planned. Pathways are to be rigid conduit placed above ceiling, or in the wall.

4) Some auditorium or large classroom configuration may require the use of external antennas connected to the WAPs. These antennas may mount as patches or poles and may require being mounted in visible locations.

5) Under seat mounting utilizes lockable RF enclosures with dimensions of 11” x 11” x 4.4”. Seating types must leave clearance for the placement of these enclosures underneath all configurations of the seating.

   (i) Under floor mounting may be used as an alternative to placing locked enclosures underneath seating, however, ITS shall be consulted for this type of design.

6) Space for RF absorbent foam may be required for WAP installations inside walls or under floor.

C. Identification on drawing floor plans

1. Communications data outlets for WAPs shall have a distinct symbol on the drawings.

D. Cabling infrastructure

1. Each communications data outlet for a WAP is to be served by one (1) category 6a outlet/cable.

2. Cable locations/mounting will be designed for below ceiling and flush mounted WAPs. Any exceptions, such as high-density locations, shall be approved by ITS.

3. The outlet backbox shall be affixed to the structure.

4. The faceplate shall be stainless steel.
5. Distance limitation of external antennae coax cable is one meter.
6. Provide (1) 7’ and (1) 25’ plenum-rated (green) patch cord. Patch cords can be coiled to reduce slack cordage. Cordage shall not be placed on top of ceiling tiles.

1.3 SUBMITTALS
A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Shop Drawings
      a) Provide scaled drawings (not less than 1/8" = 1'-0") indicating location of communications outlets for the WAPs, as well as the routing of conduits and locations of all pull points (to include pull boxes, communications LB, etc.). These locations shall be coordinated with all other trades.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
   1. Record Drawings
      a) Provide scaled AutoCad and PDF drawings (not less than 1/8" = 1'-0") indicating actual location of communications outlets for the WAPs, as well as the actual installed routing of conduits and locations of all pull points. Design or shop drawings with field notes will not be accepted.

PART 2 – PRODUCTS
2.1 GENERAL
A. ITS will provide the WAPs and related equipment (POE switches, patch cables, controllers) in its scope of the project, and can provide the architects specifications for aesthetic concerns. Equipment changes frequently, so the project must get the current part numbers from ITS.
B. Typically used WAP models (as of July 2012)
   1. Cisco Aironet 3600e Access Point
      a) Utilizes external antennas for use in indoor environments
      b) AIR-CAP3602E-x-K9 - Dual-band controller-based 802.11a/g/n
   2. Cisco Aironet 3600i Access Point
      a) Equipped with internal antennas for use in indoor environments
      b) AIR-CAP3602I-x-K9 - Dual-band controller-based 802.11a/g/n
C. Typically used antennas (for Cisco 3600e Access Points as of July 2012)
   1. Cisco AIR-ANT2566P4W-R= 2.4 GHz 6 dBi/5 GHz 6 dBi Directional Ant., 4-port, RP-TNC
      a) This will have 4 coax cables with RPTNC connectors.
   2. AIR-ANT-4210Y-R - Cisco 2.4 GHz 10dBi Yagi Antenna w/ RPTNC Plug Connector
      a) Yagi antennas are used for under floor mounting.
PART 3 - EXECUTION

3.1 GENERAL

A. ITS shall install WAPs after substantial completion (requires all cabling/mounting be installed and tested in secure communication closets).

B. Installation times will vary but a single crew consisting of two technicians will take an average of 1 hour per WAP to install, patch, and troubleshoot.

END OF SECTION
PART 1: GENERAL

1.01 Scope of Standard

This standard provides general guidance concerning the specific preferences of The University of Texas at Austin for clock and bell systems.

1.02 General Requirements

Not all campus buildings will need clock and bell systems. Verify with the University. Where a clock and bell system is needed, clocks are to be limited to classrooms and main public spaces within the building, unless directed otherwise.

PART 2: PRODUCTS

2.01 Brands

In general, the products are limited to Simplex/Valcom product lines due to the age of multiple systems in use on campus. Any other brands must be submitted prior to purchase for review, approval and demonstration of compatibility.

2.02 Clocks

1. Replacement of Existing Analog Clocks/Bells:
   - Single Sided: Semi-flush 15” wall mounted clock, Simplex 6310-9250 with 2975-9038 back box.
   - Double Sided: Wall mounted 15” double dial clock assembly, Simplex 6310 series with 2975-9024 back boxes. Ceiling mount is not allowed for Double Dial Clocks
   - Bell: Semi Flush wall mounted 4” Low db. 115VAC bell signaling device with trim plate.

2. New construction Clocks / Bells
   - Analog Clocks: 16” IP PoE Analog Clock, #VIP-A16, or double sided #VIP-A16DS
   - Digital Clocks: 4” 4 digit clocks, IP PoE 4, VIP-D440 or double sided #VIP-D440D
   - Bells: to be determined by design requirements and technology needed. Maintain compatibility to the system.
PART 3: EXECUTION

3.01 Renovation of existing buildings.

Clocks and bells in older building typically use the Simplex Sync or Impulse systems. Use the following guidelines if the existing clock system is to remain as-is or with minor modifications. (See Figure 1)

1. Simplex Building Time Control Center VE8048 IP Input/Output Module
2. Building Clock and Bell floor junction box at each level to be labeled UT Clocks.
3. Wiring to individual instruments via 3/4" EMT conduit and #14 GA wiring. Wire color coding as follows: clocks - white = neutral, black = hot, red = correction, bells -blue.
4. Category 5e cable (or approved equivilant) from VE8048 to the nearest telecommunications room, not to exceed 295 cable feet.
5. Simplex Line Amp 2301-9513 and a 12VDC Bell signaling relay on a base.
6. Not applicable.
7. Wiring pathway between Communication Terminal Room (CTR) and Communications Gateway Room via floor sleeves and 3/4" EMT conduit.
8. 120 VAC, 20 amp power circuit dedicated to building Clock and Bell system.

3.02 New Building Constuction

Clock and bell installations in new buildings shall ensure the new clocks and bells are compatible to the following equipment. See Part 2 for product guidelines.

1. Clock Application Server, model VE6011 and VE6012. These two servers are installed in the University Data Center.
2. Category 5e (or approved equivalent) cabling between clock / speaker (bells) to the nearest telecom room. Installation to be consistent with IT Policies, Standards, and Guidelines at the following link: IT Policies, Standards, and Guidelines
3.02 Typical Clock And Bell Mounting Detail

Wallmount the clocks and bells are per figure 2.

Figure 2: Clock Installation Requirements

END OF STANDARD
PART 1 - GENERAL

1.1 NOTICE OF CONFIDENTIALITY

A. Security system work is critical to the security of The University of Texas at Austin. Plans, specifications and other documentary material and information about the security system are confidential information and shall remain secure and confidential. Confidential information shall not be deliberately or inadvertently disclosed to anyone other than the Contractor's personnel and subcontractors who require disclosure to perform their portion of the work. Track confidential information and ensure that copies are accounted for and properly destroyed when no longer needed to perform the work.

1.2 PURPOSE

A. Establish design criteria, define activities, identify stakeholders and assign responsibilities as they relate to the installation of electronic access control, and intrusion detection systems for the UT Austin campuses. These guidelines are intended for Project Management and Construction Services (PMCS) projects, Office of Facilities Planning and Construction (OFPC) projects, and the UT Security Installation & Repair shop.

1.3 OVERVIEW

A. The electronic safety and security systems for UT Austin’s buildings and facilities are managed and maintained by the Information Technology Services (ITS) Security Operations department. The primary function of these security systems is to protect the campus population and assets. The University of Texas Police Department (UTPD) will monitor and respond to all approved security alarms that are a part of this campus security system. The hardware and installation requirements listed in this guide must be in full compliance in order to obtain infrastructure maintenance support by ITS and alarm monitoring by UTPD.

B. Prior to commencing work in an existing building contact ITS Security Operations (512-471-6878) and UTPD (512-471-4441) to notify them of location, activities, and start/finish times of necessary work.

1.4 ELECTRONIC SECURITY SUPPORTED AT UT AUSTIN

A. Card Access Control. This system replaces the typical mechanical key controlled door lock with a door locking system that uses an access card as the access credential. This provides added features including:

1. Student/staff ID issued by the University's ID Center functions as the access card.
2. Tailored access privileges for each user.
3. Card user access privileges can be deleted or modified without retrieving the issued access card.
4. Automatic card deactivation when a student, visitor or employee role becomes inactive.
5. Individual University Departments control their facility access controlled doors via a web interface.
6. Cancellation of all access privileges in case of lost or stolen access card.
7. Monitor and document building access activities.
8. Locking or unlocking doors performed by automatic schedule or manually via software.
9. One access card can function at other compatible UT Austin facilities.

Each system includes: an electric door-locking mechanisms, card reader located adjacent the door, door status sensor, door prop alarm and a request to exit device. Typical system configuration is card or schedule controlled entry with free exiting. To access the controlled area, users must present their cards to the card reader located near the door. The door will unlock momentarily and relock. If the door is held open or propped, a local warning buzzer will sound to remind the user to close the door before an alarm message is transmitted to the UTPD. Card access can also be used to control elevator functions.

B. Emergency Delay Exit Door. The emergency delay exit door system operates as a fire code compliant (NFPA 101) emergency exit door but will not open until a 15 second delay period has expired after an exit attempt has been initiated. Local siren sounds immediately to alert local staff of attempt to exit and police receive message with location and specific alarm information. A local fire alarm triggers the immediate release of the door(s). Local controls or programmable time schedules can be used to override this security function. Typical installations include back or side code required exits to labs, exterior building emergency exit doors and stairwell doors. These systems may also be used with card readers in interior egress applications; however, these interior applications should be provided on a limited basis only to secure areas accessed through egress doors.

C. Intrusion Detection System. This system monitors offices, classrooms, etc. for unauthorized entrance or intruder. This system can consist of motion sensors, door status sensors, glass break sensors and one or more control keypads. The keypad is used to arm/disarm system by entering a numeric code on the keypad. Alarm signals are transmitted to UTPD with location and specific alarm information.

D. Article Protection System. This system is designed to monitor various computer equipment, projectors, lab equipment etc. for unauthorized removal. A small cable attaches to the monitored equipment. Removing or cutting the cable will generate a message to the UTPD with location and specific alarm information. System is armed by entering a numeric code on a local control keypad to allow for authorized equipment removal for repair or reconfiguration.

E. Duress Button. These buttons, also known as panic buttons, are installed in locations where potential personal safety or security threats exist. Depressing the button sends a silent priority alarm signal to UTPD with location and specific alarm information. The panic button is usually located in the knee space underneath a desk or service counter. Once activated the alarm must be manually reset by UTPD.

F. Police Help Call Station. The typical system is a distinct yellow box or pole with a red call button, “Police Help” signage and a blue locator lamp. Depressing the call button puts the individual in direct voice contact with a police dispatcher along with specific location information. These can be interior or exterior installations. Typical installations are parking lots or remote areas where personal safety is a concern.

1.5 REFERENCES

A. Americans with Disabilities Act (ADA)
B. Crime Prevention Through Environmental Design (CPTED)
C. NFPA 70: National Electric Code (NEC)
E. NFPA 730: Guide for Premises Security
F. NFPA 731: Standard for the Installation of Electronic Premises Security
H. Underwriter’s Laboratories (UL) Applicable Standards
I. NECA 1: Standard Practice of Good Workmanship in Electrical Contracting
J. Electronic Industries Alliance (EIA) Applicable Standards
K. Telecommunications Industry Association (TIA) Applicable Standards
L. Institute of Electrical and Electronics Engineers (IEEE) Applicable Standards
M. OFPC Security Planning and Design Guidelines
N. The University of Texas at Austin Security System Alarm Policy
O. The University of Texas at Austin Minimum Building Security Standard
P. The University of Texas at Austin Security Standard Installation Practices
Q. The University of Texas at Austin Video and CCTV Security Systems Policy
R. Family Educational Rights and Privacy Act (FERPA)
S. Texas Accessibility Standards (TAS)

1.6 EXISTING SECURITY SYSTEM DESCRIPTION

A. Software – UTC Picture Perfect
B. Access Control - UTC Micro/5
C. Intrusion Detection – UTC NetworX Series NX-8E

1.7 QUALITY ASSURANCE

A. Contractor Qualifications
   1. Only approved security contractors may perform work on UT Austin campuses. Refer to [Appendix A] for the list of approved security contractors and instructions for becoming approved.
   2. A single security systems integration contractor shall provide the work specified in this guide and have a minimum of five years experience in the fabrication, assembly and installation of systems of similar complexity as specified herein.
   3. The security contractor shall work directly for the GC and not as a subcontractor under another trade.
   4. The security contractor shall provide an installation that falls under the manufacturer’s guidelines for warranty and is certified to work on Micro/5 and NetworX Series data gathering panels running on Picture Perfect software. These companies are referred to as “UTC Picture Perfect Certified Channel Partners”.
   5. The security contractor shall maintain a service facility and organization with staffing capable of providing comprehensive maintenance and service for the specified systems within a 100 mile radius of The University of Texas at Austin campus.
6. The security contractor shall have local in-house engineering and project management capabilities consistent with the requirements of the project. Provide a team managed by a project manager and field supervisor responsible for submittals, installation, scheduling, manpower, testing, record documents, etc. The field supervisor shall be on-site during all work activities to ensure quality, compliance with contract documents and coordination with other trades.

7. The contractor shall maintain a spare parts inventory necessary to resolve component failures of the system. Spare part inventory shall include the following:
   a. DGP boards
   b. Card readers
   c. Power supplies
   d. Door position switches
   e. Door management units
   f. Local door alarms
   g. Motion sensors
   h. Glass break sensors
   i. Telephone call stations

B. Documentation to include with Bid Proposal

1. Proof of security contractor licenses from the Texas Department of Public Safety’s Private Security Bureau for both the firm and employees working on-site.

2. Proof of on-site personnel manufacturer certifications, training and licenses as required to purchase, install, modify, and service the specified systems.

3. Provide a list of three projects within the last five years that utilize the specified systems. For each project, provide a name, location, description, date of completion, contact name and contact phone number.

4. Maintain factory trained and certified technicians. Certified technicians shall install and terminate security riser closet equipment including DGPs, terminal cabinets, and power supplies and shall supervise installation, commissioning, and maintenance of the work. All installing personnel shall be licensed as required by local and/or state jurisdictions. The contractor shall maintain certification information for each technician at all times and shall provide certifications to the general contractor, security consultant and ITS for verification and record.

5. If the contractor has been involved with any litigation or criminal action with a client or government agency within the past five years, provide full details and status of each occurrence.

6. Specification Compliance
   a. Provide a specification compliance statement indicating compliance or deviation for each item in the specification. The statement shall be comprised of a list of all numbered paragraphs that appear in this Specification.
b. Indicate compliance of the proposed equipment and/or services by the word “Comply” following each paragraph number.

c. Indicate an exception to the requirement by the word “Exception” following the applicable paragraph number.

d. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall indicate the clarification to the requirement with the word “Clarification” followed by a full explanation of the extent of compliance for the applicable equipment and/or services proposed.

e. Instances where there is no indication of compliance or exception shall be considered non-compliant.

f. This compliance statement is critical for proposal evaluation. Failure to submit may result in the disqualification of the proposal.

1.8 SUBMITTALS

A. Produce submittal drawings using the latest version of AutoCAD. Printed drawings shall be at least half size drawing that are suitable to show in readable detail all elements of the project, including any text or symbols.

B. Provide submittals within 30 days of contract award.

C. Prior to installation the submittals must be reviewed and approved by the security consultant and ITS.

D. Submittals shall include:

1. Equipment schedules necessary to identify products that will be provided for the project. Schedules shall include description, manufacturer, model, and quantity for each product.

2. Manufacturers’ product data sheets for all components of the security system provided by the project. These product data sheets should provide descriptive literature, illustrations, installation instructions, information on compliance with applicable standards, dimensions, model number, electrical characteristics, support requirements, connection requirements and all applicable information to verify compliance with specifications. Where more than one part number is listed on a manufacturer’s data sheet, highlight the applicable information.

3. Floor plans necessary to identify specific device locations, cable routes and quantities, cable types, riser locations, and references to installation details and diagrams.

4. Floor plans should also indicate electronic door hardware type and voltage for each door when these devices are controlled by the security system. This can be accomplished with symbols or keyed notes.

5. Device termination details necessary to ensure consistent installation by all personnel and subcontractors.

6. Data gathering panel (DGP) termination details and schedules necessary to ensure that installation personnel and subcontractors properly connect devices to the DGP, power supplies, transition equipment, and other head end equipment.

7. Complete installation drawings including system block and functional diagrams of all systems and subsystems. Terminal point to point wiring diagrams for each type of device including correct terminal or connector pin designations.
8. Power supply points listing with devices and maximum loads to prevent overloading.

9. Riser diagram showing routes between floors or other areas that are not easily identified on the floor plans.

10. Detailed elevation drawings showing DGP and associated panel layouts.

11. Completed programming forms provided by ITS Security Operations. These completed forms are necessary for ITS Security Operations to program the security system.

E. At the conclusion of approved Pre-functional Testing the contractor shall provide preliminary as-built drawings which will be an updated and fully reviewed version of the submittal (O&M’s not required at this time). Preliminary as builts must incorporate all changes to the project including security system design modifications, architectural changes and updated room numbering. This must be submitted to ITS Security Operations at least 15 days prior to Functional Testing.

F. At the conclusion of the project the contractor shall provide as-built drawings which will be an updated and fully reviewed version of the submittals. As builts must incorporate all changes to the project including security system design modifications, architectural changes and updated room numbering and be submitted to ITS Security Operations.

1.9 OPERATION AND MAINTENANCE MANUAL

A. Submit two hard copies and one electronic copy of the security O&M Manual to ITS Security Operations at the conclusion of the project. The security O&M Manual must conform to the following:

1. Ring binder with project title and contractor’s name on cover and spine.

2. Name, address, and phone number of nearest representative of each project contractor and subcontractor.

3. Table of contents

4. Tabbed sections including:
   a. Theory of operation, design philosophy, specific functions
   b. System block diagram
   c. List of system associated mechanical locking keys with key codes and tamper resistant hardware types.
   d. Equipment list, including a brief description, model, and the total number of each item used in the project.
   e. Rack and wall elevation layouts
   g. Maintenance requirements for equipment, inspections and preventative maintenance schedules.
   h. Loose leaf pocket containing: as-built drawings for each floor. Each drawing shall show: cable type and identifier, actual cable routing pathway, device number and device input/output number.
1.10 CONSTRUCTION SCHEDULE

A. The completion of the security system is heavily dependent on work by other trades. To ensure coordination with these other trades the security contractor will be responsible for providing a detailed construction schedule. See the example schedule and Gantt chart located at the following link to gain an understanding of the level of detail required. [http://www.utexas.edu/cio/policies/campus-security/files/UT%20Construction%20Schedule%20P6.pdf]

B. The schedule shall include all relevant security activities, estimated completion dates, duration of each activities and predecessor activities by other trades that impact security activities. For a list of critical activities that are dependent on other trades see [Appendix B].

C. 30 days after award of contract the security contractor shall provide a preliminary schedule for all security work with the level of detail shown in the sample schedule referred to in paragraph A above. Schedule shall conform to requirements listed in paragraph B above. Throughout the installation the security contractor shall provide updates at least once every two weeks. This schedule will allow the GC and owner to verify progress and identify any issues early on that will impact the overall construction schedule.

1.11 WARRANTY

A. The contractor shall warranty the completed work to be free of defects in workmanship and materials for a period of one year from the date of system acceptance by ITS and UTPD.

B. If the workmanship or materials is found to be defective or not in accordance with the contract documents during the warranty period, the contractor shall correct it promptly with factory certified technicians at no cost to the owner. All labor and materials shall be provided by the contractor.

C. The contractor shall provide the owner and ITS Security Operations with a 7 days per week 24 hours per day phone number that will respond to warranty service calls. A technician is required to be on-site within 8 hours of placing the warranty service call and the repair shall be completed within 24 hours of site arrival.

D. The contractor shall provide loaner equipment for any device that cannot be repaired in the field. Loaner equipment must be functionally and technically equivalent to the replaced item.

E. Immediately following a warranty service request, the contractor shall provide written notice to ITS Security Operations (seccontrol@its.utexas.edu) to confirm that a factory certified technician is being dispatched to the site with a schedule for repair. Include the technician’s name and contact information.

F. After warranty service work is completed, the contractor shall provide written notice to ITS security operations (seccontrol@its.utexas.edu) to provide details on the service work completed, cause of trouble and any other outstanding issues with a timeline on correcting them.

G. ITS security operations reserves the right to expand or add to the system during the warranty period using firms other than the contractor for such expansion without affecting the contractor’s responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment or system being expanded. Contractor shall not be responsible for maintenance of equipment installed by other firms.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products and materials must be new and approved in the pre-installation submittals.
B. Exterior devices shall be sealed and protected against weather conditions including heat, cold, moisture, dust, and sand.

2.2 BUILDING ACCESS CONTROL SYSTEM (BACS)

A. System Description

1. Provide UTC Micro/5 PXNplus panels, HID SE series card readers, and alarm input and output devices connected to the campus GE Picture Perfect security management system.

2. Provide power to locks and connect the locks to a DGP auxiliary relay to provide for card reader or BACS control of doors as programmed by ITS security operations.

3. Card Reader Controlled Doors

   a. Card reader controlled doors shall include:

      1) Card reader.

      2) Double pole double throw (DPDT) magnetic door position switch for each door leaf.

      3) 24 VDC electric locking mechanism with integral request to exit (REX) switch.

      4) All card reader doors will be keyed to a UTPD key.

   b. Typical Configuration

      1) Wire normally closed REX switch output to the REX input of the associated 2SRP.

      2) The Door shall automatically relock the lock after the door closes after a valid card read access.

4. Card Reader Controlled Doors with Automatic Door Operators

   a. Configure doors with automatic door operators as follows:

      1) Free Exit Side Push Plate

         a) The push plate shall function at all times.

         b) When pressed, the door operator push plate shall:

            (1) Signal the interface controller to unlock the door and provide a normally closed REX signal to the DGP.

            (2) Signal the door operator to open the door.

      2) Card Reader Unlock Mode

         a) The door shall be unlocked.

         b) The card reader controlled side door operator push plate shall be enabled.

         c) When pressed, the door operator push plate shall signal the door operator to open the door.

      3) Card Reader Locked Mode
a) The door shall be locked.

b) The card reader controlled side door operator push plate shall be disabled.

c) Upon a valid card read, the DGP shall provide a signal to the interface controller to:

(1) Unlock the door.

(2) Enable the card reader controlled side door operator push plate.

5. Access Controlled Doors without a Card Reader

a. Emergency exit only doors

1) Emergency exit only doors shall include:

a) Double pole double throw (DPDT) magnetic door position switch for each door leaf.

b) Door Management Unit (DMU)

c) Sign stating “DOOR IS ALARMED CONTACT UTPD PRIOR TO OPENING”

d) Access control doors without a card reader will not have exterior trim. If a key is required, it must be a UTPD key only.

2) Anytime this door is opened the DMU will sound immediately and an alarm will be sent to UTPD.

b. Exit doors with request to exit switches

1) Exit doors with request to exit switches shall include:

a) Double pole double throw (DPDT) magnetic door position switch for each door leaf.

b) Door Management Unit (DMU)

c) Request to exit switch integral to door hardware

2) Anytime this door is opened without a request to exit signal, the DMU will sound immediately and an alarm will be sent to UTPD.

3) DMU activation if the door is held open longer than an adjustable time after a valid access. Coordinate exact times for each door with ITS Security Operations.

6. Card Reader Controlled Elevators

a. Provide card reader in elevator car panel and associated digital output relay control of elevator floor select buttons. Individual digital output relays are needed for each floor select button in each elevator equipped with a card reader. Provide cabling from access control panel to elevator demarc panel. Provide individual control for each floor select button for each elevator door.

b. When an elevator is in the card reader control mode, the floor select buttons shall be disabled. The passenger shall be required to hold their access card up to a card reader
c. When the elevator is in normal mode, floor select buttons shall be enabled.

d. If elevator DGP fails the elevator will enter secure mode.

e. Card readers shall be in override anytime the elevator is in fire service mode.

f. Elevator contractor to provide the following. Verify this information with UT Elevator Services and the elevator specifications:

1) Infrastructure for Card Reader in each elevator shall require six (6) 2-conductor 20 gauge stranded, low voltage cable with an overall braided shield and drain wire, and four (4) 18 gauge stranded wires. These items shall be run from the elevator controller to the elevator car top. Provide an excess loop of six (6) feet long on each end. The excess cable loop shall be neatly bundled and located in a 6” X 6” X 4” Deep “J” box on the elevator car top. Provide an 18” x 24” x 6” deep hinged lockable “J” Box in the Machine room as a Demarc for Card Reader wiring. Provide screw terminal strips for wiring connections. Clearly label both boxes “Elevator Card Reader Future Use”.

2) Removable blank for Card Reader. The area where the future card reader will be installed in the Car Panel must be self-contained and isolated from the Elevator wiring within the car panel. The card reader must be installed using a cover panel to be removed and replaced from the finish side of the car panel using tamperproof screws. The height of this reader must be in compliance with all ADA and TAS requirements. Card reader shall be bypassed anytime the Elevator is in Fire Service Mode. See Appendix C.

7. Card Reader Controlled Elevator Hall Call Buttons

a. Provide a card reader adjacent to the elevator hall call button. When the elevator is in card reader control mode, the hall call button shall be disabled. Upon a valid card read, the BACS shall enable the hall call button and the user shall be able to select the button for access.

b. When the elevator is in normal mode, hall call buttons shall be enabled.

c. Card readers shall be in override mode anytime the elevator is in fire service mode.

8. Special Function Card Reader

a. Connect special function card readers to DGP card reader inputs.

b. ITS Security Operations will program special function readers to provide functions as required.

B. Equipment Requirements

1. Access Control Panel

a. Provide UTC Micro/5 control panels with (NO EXCEPTIONS):
1) PXNplus CPU board with latest firmware level as approved by ITS Security Operations.

2) Primary communications with the BACS server via RJ45 Ethernet connector.

3) Daughter board plug-in dial-up modem for secondary communications with the BACS server via RJ11 connector on controllers with exterior doors.

4) 2SRP card reader interface boards.

5) 5 volt communication chips for the card reader interface boards.

6) 16 DOR relay output boards. Must be placed in slot 4 in the micro unless otherwise approved.

7) 20 DI input boards (minimum one 20 DI board per Micro). Must be placed in slot 5 in the micro unless otherwise approved.

8) Minimum of one spare card slot for future microcontroller expansion.

9) Minimum of 20 percent spare alarm input and output points.

10) A separate manufacturer-approved power supply for each DGP.

11) UTC M5 enclosure.

12) Micro enclosure tamper switch wired as a discrete input to the power/com board.

13) Micro AC fail wired as discrete input to the power/com board.

14) Inputs and outputs associated with the same device must reside on the same controller.

15) The following supervised alarm inputs will be monitored as discrete alarm inputs on the 20 DI board (XX = micro account number) in this order: Micro XX PS Battery Fail, Micro XX PS Tamper, Micro XX Lock PS AC Fail, Micro XX Lock PS Low Battery, Micro XX Lock PS Tamper, Micro XX Termination Tamper.

2. Termination Cabinet

   a. Provide Base Electronics LVPC-201677 (NO EXCEPTIONS) terminal cabinets with 201678 (NO EXCEPTIONS) terminal blocks to terminate system cables as follows:

      1) Provide one cabinet for each BACS control panel.

      2) Fully equip the cabinet with six terminal blocks regardless of the number of cables terminated within the cabinet. Blocks must installed in the same order as the micro.

      3) Terminate BACS field device cables (e.g. card readers, door position switches, other alarm input devices, motion sensors, duress buttons, etc.) to the left side of the terminal blocks.

      4) Provide individual patch cables from the terminal cabinet to the DGP for all DGP inputs and outputs including spares. Large multi-conductor cables shall not be acceptable for patch cable connections. Patch cable overall conductor counts, conductor sizes, and insulator colors shall match incoming cables.
5) Terminate each DGP input/output, including spares, to the terminal blocks. Terminate wires from the DGP to the right side of the terminal blocks.

6) The intent is to minimize access to the DGP cabinet for troubleshooting and field modifications and maintain a neat and serviceable DGP.

3. Proximity Card Readers
   a. Card Reader Applications
      1) Wall Mount and Special Function: HID SE SERIES (NO EXCEPTIONS).
      2) Mullion Mount: HID SE SERIES (NO EXCEPTIONS).
   b. LED Configuration
      1) Red LED for locked state
      2) Green LED for unlocked state and valid card read
   c. Associated Power Supplies
      1) Wall-mounted and Mullion mount card readers shall be powered from the 2SRP at 5 VDC.
      2) Card Reader/Keypad shall be powered from a fused auxiliary power supply at 12 VDC.

4. Request to exit (REX)
   a. Doors equipped with electrified locksets or crash bars shall have integrated REX switches.
   b. REX motion sensors can only be installed with prior approval from ITS Security Operations.

5. Door Position Switches
   a. Concealed Magnetic Door Position Switch: Provide Sentrol 1076D Series or approved equal door position switches.
   b. Surface Mount Door and Hatch Position Switch: Provide Sentrol 2500 Series or approved equal surface mount door position switches.
   c. Overhead Door Position Switch: Provide Sentrol 2300 Series or approved equal surface mount door position switches.
   d. Provide armored cable from surface mount and overhead switches to the associated junction box to conceal and secure the wire.

6. Door Management Unit
   a. Provide Designed Security, Inc. (DSI) ES4200-K0 configured for 24VDC (NO EXCEPTIONS).
   b. Typically used on door without a card reader.
   c. Configure DMU as follows. See [Appendix D]:
1) Connect one DPDT door position switch output to the DMU door status input.

2) When a door is equipped with an electrified lock connect the DMU voltage sense input in parallel with lock voltage after the DGP lock control relay output. The DMU shall shunt and allow access when lock is electrically activated to unlock.

3) Wire the integral REX switch output to the REX input of the DMU.

4) When a door is not equipped with an electrified lock connect the DMU reset/bypass input to DGP control point relay output to provide remote momentary reset and/or maintained bypass.

5) Connect DMU alarm output to DGP alarm input for alarm monitoring.

6) Immediate local alarm activation if the door opens without a valid access input.

7) DMU activation if the door is held open longer than an adjustable time after a valid access. Coordinate exact times for each door with ITS Security Operations.

8) DMU shall reset automatically after the door returns to a closed position.

7. Delayed Exit Device Controller
   a. Provide Securitron Model XDT-24 (NO EXCEPTIONS). Locate the controller above the secured side of the door. Provide additional cabinet as required to provide a neat and serviceable installation. See [Appendix E]:

   b. Signage requirement for exit only delayed egress door. Signs should be mounted above the crash bar and have a red background with white letters that are 1” tall with a 1/8” stroke width (NFPA 101 requirement). ITS and UT Fire Prevention Services shall approve sign language upon request prior to installation.

8. Tamper Switches
   a. Sentrol 3010 series or approved equal plunger type normally open tamper switches to monitor the secure status of all DGP’s, power supplies, terminal cabinets, power distribution units, and other Security System cabinets and enclosures. Tamper switches will be in the closed state when depressed.

   b. Fasten tamper switches within the cabinet to provide no access to the switch and fasteners when the cabinet is closed.

   c. Provide independent monitoring of tamper conditions for each cabinet. Include the number of tamper switches in the total alarm input figures.

9. End of line (EOL) Resistor Terminations
   a. Field (Device) End

      1) Provide GRI 6644T Standard Series Parallel Resistor Packs with 2 – 1K 1/8 watt 5% carbon film with 2 blue and 2 black 12-inch leads.

      2) Locate EOL Resistor Terminators at the end of the cable being supervised and within device housings when possible.

   b. Panel End
1) Provide GRI 6644T Standard Series Parallel Resistor Packs with 2 – 1K 1/8 watt 5% carbon film with 2 blue and 2 black 12-inch leads.

2) Locate Resistors at the end of the cable within the panel housing.

10. Tamper Resistant Screws

   a. Provide Torx® fasteners with pins tamper resistant screws for the following applications:
      1) Junction boxes located above doors.
      2) Junction boxes located below ceiling height and/or within reach of hatch ladders.
      3) Device cover plates.
      4) Surface mounted door position switches and armored cable.
      5) Duress buttons.
      6) Card Readers

   b. Provide appropriate screw heads for each application (e.g. countersunk heads for recessed cover plate screws, flat head screws for standard junction box covers, etc.).

11. Power Supplies

   a. Provide Altronix / AL Series or approved equal UL Listed Class II power supplies for BACS equipment and electric locking devices.

   b. Some electronic locking hardware require a 120VAC power supply at the door. In these instances the door hardware installation contractor shall be responsible for furnishing and installing the locking hardware manufacturer’s recommended power supply. Verify with UTS Security Operations and security consultant to determine if a remote power supply is required.

   c. Power supplies shall provide the following:
      1) A switch and on/off indicator within the power supply cabinet.
      2) Four hours of sealed gel battery backup to provide continuous operation during power failure. Provide batteries as required to provide specified battery backup time for a fully loaded power supply, regardless of the connected load.
      3) Each battery shall be permanently labeled with the date of manufacturer and date of installation (month & year). The date of installation is the month & year that the battery was placed in the power supply and began charging.
      4) A battery charger to maintain the battery.
      5) Low battery and power fail contacts to monitor the status of the input power and the battery. Connect each power supply low battery and power fail alarm as a separate alarm input into DGP.
      6) Key lockable wall mount metal enclosure with tamper switch. Coordinate keying requirements with ITS Security Operations.
d. Additional DGP Power Supply Requirements

1) The DGP power supply provide power only to DGP’s and shall not provide power for locks or any other low voltage device.

e. Additional Electric Locking Mechanism Power Supply Requirements

1) 24 VDC output.

2) Provide (1) lock power supply per DGP.

3) Fail secure electric locking mechanisms shall remain locked during power failure and fire alarm conditions.

4) Connect fail safe locking devices in accordance with applicable life safety codes to unlock automatically under the following conditions:
   a) Loss of power to the power supply.
   b) Failure of the power supply.
   c) Fire alarm activation if required by UT Austin Fire Prevention Services.

5) Provide power distribution boards with independently fused output relays and fire alarm control panel interface.

f. Additional Device Power Supply Requirements

1) Provide device power supplies for other security system devices requiring power (e.g. card readers, local alarms, motion sensors, etc.)

2) Provide power distribution boards with independently fused outputs.

C. System Interfaces

1. Electric Locking Mechanisms

a. The security consultant and door hardware consultant shall coordinate all door hardware, door and door frame design. The door hardware consultant shall be responsible for specifying all access control door hardware based on security consultant input and ensure consistency with project hardware. The security consultant shall verify all specified door hardware is appropriate for the security application. In addition, the security consultant must specify the sequence of operations for each access controlled opening and define termination requirements for the security contractor.

b. UT preferred electronic lock manufacturers:

1) Electrified Exit Device
   a) Sargent (Assa Abloy)
   b) Von Duprin (Ingersoll Rand)
   c) Corbin-Russwin (Assa Abloy)

2) Mortise Locks
a) Sargent (Assa Abloy)
b) Corbin-Russwin (Assa Abloy)
c) Schlage (Ingersoll Rand)

3) Magnetic Locks
   a) Locknetics (Ingersoll Rand)
b) Rutherford Controls (RCI)

4) Cylindrical Locks are prohibited

2. Elevator Control System
   a. The security consultant must verify the elevator security requirements with ITS Security Operations and coordinate with the elevator consultant to ensure the appropriate system interfaces are in place.

3. Fire Alarm and Life Safety
   a. The security consultant must coordinate the access control system design with the life safety consultant to insure compliance with applicable codes and requirements. This includes, but is not limited to, the fire alarm interface, fail safe/secure locking mechanisms, and delayed egress.

2.3 INTRUSION DETECTION SYSTEM

A. System Description
   1. Provide UTC NetworX Series NX-8E panels and alarm devices for intrusion detection and article protection connected to the campus UTC Picture Perfect security management system.

   2. Provide NX-148E keypads conveniently located near areas being protected so that maintenance personnel and UTPD can arm and disarm. Coordinate locations with UTPD and end user.


B. Equipment Requirements
   1. Intrusion Detection Panel
      a. Provide UTC NetworX Series NX-8E panel with (NO EXCEPTIONS):
         1) NX-590E network module to provide primary communication to the servers via RJ45 network connection.
         2) Secondary communication via dial-up modem is required if panel has panic buttons or is monitoring an exterior door.
         3) Provide additional NX-148E keypad located next to each NX-8E panel to provide a maintenance and troubleshooting interface.
         4) NX-590E, NX-216E, NX-507E, NX-148E and NX-320E modules as required. Use the NX-003C enclosure when NX-216E modules are required.
5) A shielded 20/4 conductor wire shall be installed between all UTC NetworX panels located in the building.

6) Consult with ITS Security Operations regarding intrusion design and installation.

2. Article Protection
   a. Provide Cat5e network cable from the NX-8E control panel to the article location.
   b. Terminate the blue wire pair to a zone alarm input at the control panel.
   c. At the devices end terminate an RJ11 connector to the end of the Cat5e cable.
   d. Provide surface mount RJ11 “biscuit” block with a 3.3k resistor terminated across the red and green at each device interface location.
   e. Pass the cable through permanently affixed security plate/loops and connect to the termination block.
   f. Provide NX-148E keypads conveniently located near the articles being protected so that maintenance personnel can arm and disarm. Coordinate location with UTPD and end user.
   g. Terminate cable conductors to the termination block above the accessible ceiling. Provide 50 feet spare cable to allow ITS Security Operations to relocate termination as required to the final device location. Coil, bundle, and label the cable and terminal block.
   h. Neatly wrap unterminated wire pairs around the cable for potential future connection.
   i. Consult with ITS Security Operations regarding article protection design and installation in the building.

3. Motion Detector
   a. Provide dual technology (microwave and infrared) to prevent false alarms. Specific model depends on application and mounting requirements.
   b. One motion detector per zone, do not wire in series.

4. Glass break Detector
   a. Contractor will need to provide compatible glass break tester for device being installed.
   b. One glass break detector per zone, do not wire in series.

5. Duress Buttons
   a. USP model HUB-2B (NO EXCEPTIONS)
   b. These buttons, also known as panic buttons, are installed in locations where potential personal safety or security threats exist. Depressing the button sends a silent priority alarm signal to UTPD with location and specific alarm information. The panic button is usually located in the knee space underneath a desk or service counter.
   c. Duress button locations must be reviewed and approved by UTPD.
   d. One duress button per zone, do not wire in series.
e. 30 feet service loop in ceiling when mounting on non-fixed furniture.
f. Consult with ITS Security Operations regarding duress button design and installation in the building.

6. Police Help Buttons

a. System Description
   1) These are the red mushroom buttons commonly seen in parking garages. Pressing the button will notify UTPD that assistance is needed and provides them with location information.
   2) One police help button per zone, do not wire in series.
   3) Signs should be mounted next to button and read: “POLICE HELP”. These should also include the associated zone number. Coordinate sign requirements with ITS Security Operations.

b. Equipment
   1) Square D model 9001KR25R with 9001K93RM metal mushroom button.

2.4 POLICE HELP CALL STATIONS

A. System Description
   1. The police help call station shall consist of security telephone call stations connected to analog telephone lines with blue locator lights and appropriate signage.
   2. Provide one outside plant rated Cat5e cable from each telephone to the nearest telecom patch panel or 110 blocks.
   3. Provide 120VAC power for associated lighting.
   4. Terminate telecom cables following the existing telecom cabling labeling convention.
   5. Coordinate extension numbers, telephone numbers, and other programming requirements with ITS.

B. Equipment
   1. Stanchion Security Telephone Call Stations
      a. Provide Talk-A-Phone ETP-MT Emergency Phone Tower with constantly lit blue light and ETP-400C telephone. Button on phone should say “To Call”.
      b. Provide safety yellow tower (#02SF) with blue lettering (#A7822R) as coordinated with ITS.
      c. Provide manufacturer recommended foundation.
   2. Wall Mount Security Telephone Call Stations
      a. Provide Talk-A-Phone ETP-401C telephone. Button on phone should say “To Call”.
      b. Provide constantly lit blue light above wall mounted police help phone. Talk-A-Phone ETP-EL or equivalent.
2.5 WIRE AND CABLE

A. Description

1. Provide wire and cable infrastructure for all security system components.

B. Minimum Requirements

1. Conductors and cable shall be UL approved for its intended application and shall meet all national, state, and local code requirements for its application.

2. Conductors and cable shall meet individual security system manufacturer specifications.

3. Provide shielded conductors and cable as required by the manufacturer or as required to provide for interference-free signals.

4. Color coding shall be accomplished by using solidly colored insulation. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by NEC.

5. Increase conductor sizes on cables as required to be consistent with circuit current ratings, length of wire runs, and manufacturers’ recommendations.

6. Composite cables are not an acceptable alternative.

7. Due to wire run distance, electronic locks may require a larger gauge wire or remote power supply to work properly. Contractor will be responsible for determining distance, power supply, and wire gauge requirement. Confirm requirements with ITS Security Operations.

8. Patch Cables

   a. Provide pre-manufactured patch cables (cable, connectors, boots, etc.) as required to connect security systems to voice and data communication outlets.

   b. Patch cables shall be certified for their specific use to meet or exceed applicable industry specifications (e.g. EIA/TIA, ETL, UL, CSA, etc.).

   c. Provide cable lengths as necessary to neatly route cables through cable management systems and other cable organization systems.

   d. Provide connectors as required for proper termination. Provide boots for connectors where applicable to prevent snagging.

   e. Provide Cat5e patch cables as required for the connections of security equipment. Confirm Cat5e cabling specifications and requirements with ITS.

   f. Provide cable jacket colors as follows:

      1) Blue for data cables.

      2) White for voice cables.

      3) White for security cables except for direct burial cables.

C. Minimum Conductor and Cable Types and Sizes.

1. Security contractor to verify maximum distances and size wire accordingly
2. Low Voltage Power Cable
   a. 18 AWG (4 conductors minimum per locking device), stranded, insulated, and jacketed.

3. Card Reader Cable
   a. 18 AWG (6 conductors minimum), stranded, shielded, insulated, and jacketed.

4. Keypad Cable
   a. 20 AWG (4 conductors minimum), stranded, insulated, and jacketed.

5. Alarm Point Monitoring Cable
   a. 20 AWG (4 conductors minimum per input or alarm point), stranded, insulated, shielded and jacketed.

6. Siren, Speaker, and Control Point Cable
   a. 18 AWG, (4 conductor minimum )stranded, insulated, and jacketed.

PART 3 - EXECUTION

3.1 COORDINATION

A. Security contractor shall be required to coordinate installation activities with the following divisions or groups:

1. Door hardware, doors and door frames by contractor.
2. Electrical power and pathways by contractor.
3. Telecom voice and data cabling and outlets by contractor.
4. Fire alarm interface by contractor.
5. Elevator demarc panel, traveling cables and elevator car card reader enclosure by contractor.
6. IP and phone number assignment by ITS.
7. Security system programming by ITS security operations.

B. Meetings

1. Coordination meetings shall include the following in addition to regular project meetings coordinated by the general contractor. Contractor shall store meeting minutes, meeting agenda, sign-in sheet and handouts in the Commissioning and Closeout Manual.

2. Project Kickoff Meeting
   a. The intent of this meeting is to:
      1) Introduce the ITS representative, security consultant and construction teams.
      2) Identify communication channels and process.
      3) Establish expectations.
4) Review the project scope and requirements.
5) Establish schedule for provision and review of submittals.
6) Answer questions and resolve any issues.

3. Pre-Installation Meeting
   a. The intent of this meeting is to:
      1) Review the construction schedule.
      2) Coordinate requirements and schedules of other trades related to the security system.
      3) Review issues and/or problems as necessary.

4. Meetings with Other Trades
   a. The intent of these meetings are to coordinate requirements with other trades as required to:
      1) Review the details for each interface.
      2) Ensure that each trade understands requirements for the interface with the security system.
      3) Verify interface responsibilities and close any necessary gaps in scope of work.
      4) Resolve issues as required.
   b. The initial coordination meeting shall involve all trades related to the security system.
      Additional meetings will be scheduled as necessary for additional coordination.
   c. The general contractor will be responsible for scheduling coordination meetings.

3.2 INSTALLATION

A. General
   1. Coordinate equipment installation requirements with other trades prior to installation.
   2. After installation, protect equipment to prevent damage during the construction period. Close openings in conduits and boxes to prevent the entrance of foreign materials.
   3. Make equipment connections in accordance with the approved submittal drawings and manufacturer specifications.
   4. Seal exterior devices to protect against weather conditions including heat, cold, moisture, dust, and sand.

B. Equipment
   1. Field-verify specific equipment locations to provide the best fit and function. Verify locations with the Architect as necessary.
   2. Install equipment in accordance with manufacturer specifications.
   3. Install equipment to allow adequate clearance for testing and maintenance.
4. Locate end of line resistors within the device housing.

5. Provide tamper resistant screws and fasteners for equipment located in accessible and/or public areas.

6. Remove dirt, packaging, wiring scraps, and other debris from equipment, boxes, cabinets and work areas at the end of each work day.

7. Wherever possible, remove contractor and manufacturer equipment logos from security field devices.

8. Final approved program sheet submitted to ITS will be placed in a clear plastic sleeve mounted on the inside door of the controller for future reference.

9. Accessibility Coordination
   a. When mounting card readers or other devices that require accessibility coordinate with the architect and other trades to ensure ADA requirements are being met.
   b. Doors with both a card reader and automatic door operator push plate should have both of these devices placed next to each other.
   c. On the pull side of a single door, place the card reader on the latch side of the opening. On the pull side of double doors, place the card reader on the right side which is generally the path of travel.
   d. Card readers should generally be mounted 48” from an inside corner and 42” above finished floor.
   e. On the pull side of a door, card readers should be mounted 48” from the door jamb so that a wheelchair would be clear of the swing of the door.

10. All power transfer hinges or other devices that provide a wiring path from the door to the frame must be serviceable without having to remove the door.

3.3 CONDUIT, BOXES AND RACEWAYS
   A. Conduit must be a minimum of ¾ inch (flex is not allowed). Junction boxes must be a minimum of 8x8x4, pull boxes, wire troughs, and wire ways dedicated to security will be provided by electrical contractor. Provide additional conduit necessary to complete the installation, but not provided.
   B. Provide conduit between power sources provided under a separate section and security system low voltage power supplies.
   C. Provide conduit from interface terminal cabinets to security pull boxes.
   D. Carefully install conduit, properly and adequately support conduit as required to comply with the requirements specified herein and as required by the NEC, and provide a neat, workmanlike installation. Support horizontal conduit runs with clamps, pipe straps, special brackets, or heavy iron ties secured to building structure.
   E. Lay out and install conduit runs to avoid proximity to hot pipes. In no case shall a conduit be run within three inches of such pipes, except where crossings are unavoidable, and then the conduit shall be kept at least two inches from the covering of the pipe crossed.
   F. Provide fire stops where conduits penetrate fire rated walls and/or floors.
G. Provide tamper resistant screws or fasteners for junction boxes located in accessible and/or public areas.

3.4 WIRING TECHNIQUES

A. Wire installation is not specifically detailed in the Contract Documents. Determine conductor requirements for each device in accordance with the Contract Documents and manufacturer requirements.

B. Install cable in accordance with Security System manufacturer requirements and NEC.

C. Color code and terminate conductors consistently as follows:
   1. Red for positive and black for negative DC power leads.
   2. White for positive and green for negative alarm loop conductors.

D. Run wiring within conduit or exposed within walls, neatly above accessible ceilings, and in riser closets.

E. Arrange cables within access panels to allow for removal of the access panel and access to equipment within the panel. Arrangement shall also be in a neat and workmanlike manner. ITS Security Operations shall hold the final, authoritative opinion on what constitutes a neat and workmanlike manner. Failure to meet Security Operations’ expectations in this matter shall result in Security Contractor to redress cabling/installation to Security Operations’ satisfaction, at no additional cost to the project.

F. Neatly route cables parallel or perpendicular to building lines.

G. Provide J hooks and other cable support systems (spaced at regular intervals) within accessible ceiling spaces. Fasten cables to the cable support systems and provide strain relief to protect cables and ensure compliance with required cable bends.

H. Keep cable not run in conduit a minimum of 18” from high voltage (120 VAC and above) circuits (e.g. light fixtures, wire run parallel with conduit, transformers, electric panels, etc.).

I. Run cables at least six inches from the communications cable plant, intercom wires, input/output wires, and siren wires.

J. Route wire and cable as required to prevent interference and signal contamination of both Security System cable and cable associated with other systems. Coordinate the routing of wire and cable requiring isolation from power, radio frequency (RF), telephone, etc.

K. Provide sleeves and code compliant fire proofing techniques for all penetrations of fire rated partitions, masonry walls, and slabs, where the penetrations are made by or used for installation of Security Systems.

L. Separate high voltage (120 VAC and above) cables from low voltage cables within enclosures to comply with NEC requirements.

M. Fasten approved wire management hardware (bridle rings, j-hooks, etc.) to the building structure and/or cable tray at least every 10 feet where not in conduit. Do not lay or fasten cables to electrical conduits, light fixtures, piping, mechanical equipment, or ceiling grids.
N. Run wire and cable continuous from device location to the final point of termination. No mid-run cable splices will be allowed except where cables must transition from one type to another (e.g. underground cable to plenum cable). Provide the following where cable transitions are required:

1. Provide labeled terminal strips inside lockable cabinets at cable transition locations and document locations in the submittals.

2. Label terminal cabinets and document labels in record documentation.

3. Provide the same number of conductors and insulator colors for each cable type from the security device to the DGP location.

4. Where shielded cable is required, the shield must also be spliced.

O. Visually inspect wire and cable for faulty insulation prior to installation.

P. Provide bushings, grommets, and strain relief material where necessary to prevent abrasion of wire and excess tension on wire and cable.

Q. Component Connections

1. All security component connections from device to wire/cable shall be soldered and individually heatshrinked from jacket to jacket. Exposed conductors are not acceptable.

2. All security panel connections from wire/cable to terminal blocks shall be soldered, tinned, and heatshrinked from jacket to jacket. Exposed conductors are not acceptable.

3. Wire nuts and crimp type connectors shall not be an acceptable means of connecting wire and cable.

R. Neatly install and terminate wire and cable within DGP’s, power distribution cabinets and other security enclosures. Pull cables tight, remove slack, and route in such a way as to allow direct, unimpeded access to the equipment within the enclosure. All wires within DGP and all panels must be tinned and heat shrink used to insulate the wires.

S. Bundle and tie wire and cable with Velcro hook & loop type or similar cable ties.

T. Provide heat-shrink to insulate wire connections. The use of electrical tape shall not be acceptable.

U. Cover exposed high voltage (120 VAC and above) power terminations within DGP’s, power distribution cabinets and other security enclosures.

V. When electric locking mechanisms or power transfer hinges come with factory terminated connectors, the contractor shall consult with ITS Security Operations prior to removal. Under no circumstances will the contractor be allowed to cut these connectors off without consulting ITS Security Operations.

3.5 POWER REQUIREMENTS

A. 120 VAC emergency power dedicated to security will be provided by the electrical contractor.

B. Connect to AC power and provide UL listed power supplies and transformers to distribute low voltage power to the system components as required.

3.6 GROUNDING

A. Ground all equipment and cables in accordance with manufacturer requirements and instructions.
B. Ground cable shields and drain wires as follows:

1. From the field devices, terminate shield drain wires to the terminal cabinet ground bar.
2. Bond the terminal cabinet and micro cabinet ground bars to the DGP ground bar with a minimum 12 AWG solid conductor green grounding wire.
3. Do not terminate shields and drain wires between the terminal cabinet and DGP.

3.7 LABELED FRAMES AND DOORS

A. In no instance shall any UL labeled door or frame be drilled, cut, penetrated, or modified in any way.
B. The Contractor shall be responsible for replacing any labeled door or frame that is modified without written approval from the Architect.

3.8 LABELING

A. All labels shall be based on final UT door and room numbering scheme. ITS Security Operations shall be consulted on labeling prior to installation.
B. All cables need to be labeled alike at both ends.
C. Permanently mark all terminals. Terminal and cable markings shall agree with markings shown on as-built drawing.
D. Label the top of each card reader with the door number shown on final security system program sheet that has been approved by ITS security operations.
E. Neatly coil and secure spare conductors in the ceiling, device back box or panel wire way. Neatly bundle and tag conductors.
F. Label equipment including, but not be limited to DGPs (label to denote DGP address), power supplies, and termination cabinets. Coordinate names, fonts, styles, and devices to be labeled with ITS security operations prior to labeling. Provide computer-generated labels; handwritten labels shall not be accepted.
G. Identify power circuits and breaker locations within each power supply cabinet. This shall include any remote power supplies.
H. Label Materials

1. Conductor and Cable Labeling
   a. Provide T&B Shrink-Kon Type HVM or equal labels.
   b. Labels shall be computer generated and fastened to conductors/cables with transparent heat shrink material. Hand-written labels shall not be accepted.

2. Equipment Labeling
   a. Engraved plastic with contrasting letter colors.
   b. Half-inch minimum size lettering
   c. Fasten labels with permanent adhesive.
I. Label wires and cables as follows:

1. Mark all wire and cable in common at both ends.
2. Install markers to be readable from left to right or top to bottom. Locate labels near termination points.
3. Install labels when wire and cables are installed.
4. Labeling shall agree with record documentation.

J. Control Panels, Power Supplies and Termination Cabinets

1. All Micro/5 and NX-8E control panels will be assigned a unique account number by ITS security operations after the contractor submittals have been reviewed. Labels on each Micro/5 and NX-8E control panel shall read: “ACCT: XXXX”. XXXX represents a 4 digit account number.
2. Each termination cabinet associated with a Micro/5 shall have a label that reads: “MICRO XXXX TERMINATION”. XXXX represents a 4 digit account number.
3. Each power supply associated with a Micro/5 or NX-8E shall have a label that reads: “MICRO XXXX YYYY PS”. XXXX represents a 4 digit account number and YYYY represents the type of equipment being powered. For example “MICRO 1234 LOCK PS” represents the lock power supply for Micro #1234.

K. Micro/5 Cables
Accounts: 0001-2000
Micro account – 4 digits
Board – 1 digit
Address – 2 digits
Device – 2 characters
Input (DI) or output (DO) – 2 characters
Examples:
[account#]_[board#]_[address#]_[input or output type] [device type] [room or door number]

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L. NX-8E Cables
Accounts: 3001-9999
Account – 4 digits
Zone – 3 digits
Device – 2 characters
Examples:
[account#]_[zone#]_[input or output type] [device type] [room or door number]

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3.9 PROGRESS OBSERVATIONS

A. Security consultant and/or ITS will conduct progress observations during construction to verify construction progress and verify the construction schedule. Coordinate progress observation site visits with the Contractor. Provide Contractor with copies of progress observation reports and other applicable documentation for inclusion in the Commissioning and Closeout Manual.

B. Security consultant and/or ITS will conduct the following minimum progress observations:

1. Security Conduit Rough-in and Preliminary Wire and Cable Installation
   a. The intent of this observation is to verify that adequate and proper conduit rough-in is installed, verify that wire and cable are being properly installed and labeled, and identify and resolve issues regarding conduit and wire and cable installation.

2. Preliminary Wire Termination Progress
   a. The intent of this observation is to verify that the contractor will install and terminate equipment in accordance with specifications and ITS standards.
   b. Observations will occur upon initial installation of each type of equipment (e.g. Panels, Card readers, alarm devices, junction boxes, etc.).
   c. Observations must be complete prior to proceeding with the installation of remaining similar or like equipment.

C. Security contractor shall coordinate appropriate timing of each observation with the general contractor, security consultant and/or ITS as required to meet intended goals.

D. The inspectors will issue reports for each observation to summarize findings and document clarifications noted during the observation.

3.10 COMMISSIONING

A. Commissioning of the security system shall comply with the requirements in section 01 91 00.

B. The following activities must take place to complete the installation of the security system. Documentation of activities, corrective action items and status, and activity completion verification shall be provided to the Contractor for inclusion in the Commissioning and Closeout Manual.

1. Pre-functional Tests (PFT)
   a. Utilize PFT checklists created by ITS.
   b. Test and document security device connections with a multi-meter to verify proper termination and operation.

2. Operational Field Testing with ITS
   a. Submit updated security system program sheets and completed PFT checklist to ITS.
   b. Operational Field Testing can be scheduled once the communications cabling contractor has completed the portion of the voice and data network which supports the new security system.
   c. The completed PFT form will initiate the IP address and phone number assignments for each security control panel.
d. ITS will review updated system programming forms and make changes as needed.

e. Conduct a complete security system test of each alarm point and signal and document results on checklist. While conducting this test, the contractor shall be in direct communication with security operations as they observe the signals on their screen. The intent of this test is to verify proper system operation and ensure accuracy of system programming prior to functional testing.

3. Functional Tests (FT)

a. Utilize FT checklists created by ITS.

b. Contractor shall provide two sets of preliminary as-built drawings to ITS and the security consultant at least 15 days before the FT process is scheduled to start.

c. Once PFT and operational field testing procedures have been documented and completed, the final FT walkthrough can begin. The contractor shall demonstrate to ITS and the security consultant during a full walkthrough inspection that the completed and integrated system complies with the contract documents, initial training is complete, and the system is fully operational.

4. Integrated System Test (IST)

a. Consult ITS Security Operations on IST

b. Test critical system interfaces such as fire alarm and elevators.

C. Substantial completion requirements:

1. All alarm points and devices shall be fully installed and operational.

2. Any punch list items as a result of the FT or IST will not interfere with the operation of the security system.

END
APPENDIX A

To perform work on campus a security contractor must meet the qualifications outlined section 1.6, “QUALITY ASSURANCE, Contractor Qualifications” of this document.

Companies desiring to be considered for performing security work at UT Austin should submit their qualifications meeting the requirements described in section 1.6, “QUALITY ASSURANCE, Contractor Qualifications” of this document. Please be advised that the review process takes 60 days from receipt of acceptable package to date of approval. This timeline will not be modified to accommodate circumstances.

Submit complete packages to:

The University of Texas at Austin
ITS - Campus Security Operations C3800
PO Box 7580
Austin, Texas 78713-7580

Below is a list of companies that have demonstrated that they meet these requirements.

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>City</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diebold Security</td>
<td>9701 Dessau Rd., Bldg 1, Ste 104</td>
<td>Austin</td>
<td>TX</td>
</tr>
<tr>
<td>Entech Sales &amp; Service</td>
<td>10139 Metropolitan Dr</td>
<td>Austin</td>
<td>TX</td>
</tr>
<tr>
<td>Nathan Alterman Elec.</td>
<td>14703 Jones Maltsberg</td>
<td>San Antonio</td>
<td>TX</td>
</tr>
</tbody>
</table>
## APPENDIX B

### CRITICAL SECURITY MILESTONES BY CALENDAR DAYS PRIOR TO SUBSTANTIAL COMPLETION

<table>
<thead>
<tr>
<th>DURATION IN DAYS</th>
<th>CRITICAL MILESTONES</th>
<th>PREREQUISITE START CONDITIONS</th>
<th>DAYS before SUBSTANTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Wire and cable installation.</strong></td>
<td>1. Pathway, conduit and cable tray installation is complete.</td>
<td>98</td>
</tr>
</tbody>
</table>
|                  | **Access control, intrusion detection & CCTV system head end equipment installation.** | 1. Equipment rooms are complete.  
2. Plywood is on the wall for wall mounted enclosures.  
3. Equipment rack is installed for DVR.  
4. Power is available.  
5. Ground bar is installed. | 70                      |
|                  | **Field device wiring & termination for access control.**                          | 1. Door, frame and hardware are installed and functional.                                      | 70                      |
|                  | **Wall mounted devices installation.**                                             | 1. Paint and finish work on walls is complete.                                                | 63                      |
|                  | **Equipment Start Up**                                                             | 1. MDF completed and ITS has installed OSP feeder cables.  
2. Voice and data horizontal cabling must be installed, tested and labeled.  
3. Riser cables for connecting network switches to the gateway must be installed, tested and labeled.  
4. Network rooms that need switches for security must be complete with grounding, HVAC and locks on the door. ITS Networking will then install switch.  
5. Pre-functional test requirements complete and approved by ITS.  
6. Operational field testing completed with ITS. | 56                      |
|                  | **Functional Test**                                                                | 1. Equipment start up requirements are complete including testing with ITS security operations. | 21                      |
|                  | **Integrated System Test**                                                          | 1. Fire alarm system is complete and fire alarm relay interface to the lock power supplies is installed.  
2. Elevator controls are functional and fully operational. | 7                       |

### INSTRUCTIONS:

- **Column A:** Enter calendar days required to complete this activity
- **Column E:** Enter calendar days prior to SC this prerequisite activity must be completed
Detail showing top view of Card reader inset in Car Panel

Card reader enclosure supplied by Elevator fixture vendor to maintain isolation of card reader from elevator control components. Provide knock out for shielded travel cable and power wiring to feed the card reader through the bottom of box.

Car panel enclosure

10-27/64"  

7-1/2"

15/32"

Stainless Steel to be rabbitted to allow card reader panel to be flush with finish side of car panel.

5-21/32"

1"

5/32"

6-5/16"

Pin in Hex Screws to attach card reader panel to front of car panel.

Reader unit by security vendor

1-5/16"

Smoked tempered Glass with rabbitted edge to be flush with return panel plate by elevator fixture vendor

Removable Rabbitted Card reader plate assy. Removes from front of car panel with tamper proof screws (Pin in Hex Screws) supplied by elevator fixture vendor.
Detail showing front view of Card reader inset in Car Panel

Front view of Car panel with rabbited removable panel has all of the card reader components affixed. Contained within an isolated enclosure within the car operating panel enclosure. Card Reader mounted on plate behind Glass (Glass required to meet the A17.1 Code)
DSI 4200 Set Up

Power to be 24 VDC
For Card Reader W/RTE and for NON-Reader applications W/ RTE & Lock Refer to Figure #1.

Jumper settings:
1-IN (if resistors are used from DPS to DMU), OUT (other)
2-IN (failsafe maglocks), OUT (fail secure mortise)
3-OUT (N/C RTE INPUT)
4-IN (RTE or card reader), OUT (other)
5-IN
6-OUT
7-IN
8-IN
9-OUT
10-OUT

TIMERS
AUTO RESET-0 (RESETS WHEN DOOR CLOSES)
ALARM DELAY-8 (30 SEC)
SILENT TIME-7 (20 SEC)
DSI 4200 Set Up

For non-card reader applications W/O RTE & lock refer to Figure #2:

Remove J4 (all others remain as listed above)
Jumper dry contact shunt (so as it remains N/C)
Provide power to voltage sense from power distribution module to allow for bypass. Set up as fail secure

****No door forced will be received.

Figure # 2
Securitron Model XDT-24 delayed egress controller wiring diagram:
## Document Modification Schedule

<table>
<thead>
<tr>
<th>Initial Publication</th>
<th>Oct. 19, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Update #1</strong></td>
<td>Nov. 11, 2010</td>
</tr>
<tr>
<td>1.1</td>
<td>Addition of Notice of Confidentiality</td>
</tr>
<tr>
<td>1.3, B</td>
<td>Addition of contact information prior to commencing work</td>
</tr>
<tr>
<td>2.2, B, 1, a, 15)</td>
<td>Updated alarm inputs</td>
</tr>
<tr>
<td>2.2, B, 3, b, 3)</td>
<td>Removed requirement for flashing red LED</td>
</tr>
<tr>
<td>2.2, B, 3, d</td>
<td>Addition of Associated Power Supplies</td>
</tr>
<tr>
<td>2.2, B, 10</td>
<td>Addition of separate specifications for Field and Panel Resistors</td>
</tr>
<tr>
<td>2.2, B, 12, e, 2)</td>
<td>Addition to Electric Lock Power Supply Requirements</td>
</tr>
<tr>
<td>3.4, E</td>
<td>Addition to arrangement of cables within access panels</td>
</tr>
<tr>
<td>3.4, R</td>
<td>Addition of Card Reader connection directions</td>
</tr>
<tr>
<td><strong>Update #2</strong></td>
<td>Jul. 26, 2011</td>
</tr>
<tr>
<td>3.2, B, 9</td>
<td>Addition of serviceability requirement of door/frame.</td>
</tr>
<tr>
<td>3.4, W</td>
<td>Addition of connector requirement for electric locking mechanisms and power transfer hinges.</td>
</tr>
<tr>
<td><strong>Update #3</strong></td>
<td>Aug. 8, 2011</td>
</tr>
<tr>
<td>2.2, C, 1, b, 1, c</td>
<td>Under electric exit devices Schlage was replaced with Corbin-Russwin.</td>
</tr>
<tr>
<td>2.2, C, 1, b, 2, b</td>
<td>Under mortise locks Von Duprin was replaced with Corbin-Russwin.</td>
</tr>
<tr>
<td><strong>Update #4</strong></td>
<td>Jan. 18, 2012</td>
</tr>
<tr>
<td>Appendix A</td>
<td>SMS was removed from the list pre-qualified security contractors.</td>
</tr>
<tr>
<td><strong>Update #5</strong></td>
<td>Feb. 2, 2012</td>
</tr>
<tr>
<td>1.5</td>
<td>Addition of Q. The University of Texas at Austin Video and CCTV Security Systems Policy to the References section.</td>
</tr>
<tr>
<td><strong>Update #6</strong></td>
<td>May. 1, 2013</td>
</tr>
<tr>
<td>Global</td>
<td>Removed all references to CCTV.</td>
</tr>
<tr>
<td>Appendix D</td>
<td>Added DMU wire termination details</td>
</tr>
<tr>
<td>Appendix E</td>
<td>Added XDT-24 delayed egress wire termination details.</td>
</tr>
<tr>
<td>2.2, B, 3</td>
<td>Changed card readers to HID SE series.</td>
</tr>
<tr>
<td>2.2, B, 7</td>
<td>Changed delayed egress controller to XDT-24.</td>
</tr>
<tr>
<td>Global</td>
<td>Changed all references from GE to UTC.</td>
</tr>
<tr>
<td><strong>Update #7</strong></td>
<td>Jul. 15, 2014</td>
</tr>
<tr>
<td>2.2, B, 6, a</td>
<td>Clarified 24VDC for DMU</td>
</tr>
<tr>
<td>Appendix D</td>
<td>Clarified 24VDC for DMU</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Appendix A</td>
<td>Added Diebold Security to list of approved security contractors and also alphabetized the list.</td>
</tr>
</tbody>
</table>
PART 1 GENERAL

1.01 Scope of Standard

A. This Standard is intended to assure that fire alarm and signaling systems at The University of Texas at Austin provide the highest level of fire safety possible. This document is not intended to be a guide specification.

1.02 Scope of Work

A. This standard is to be used in the development of all fire alarm and signaling system designs for buildings and structures at The University of Texas at Austin.

B. This standard is to apply to all fire alarm and signaling system components and equipment installed at any University of Texas at Austin campus during new construction or as part of any improvement project.

C. The work addressed in this section consists of a fire protection system, which may include, and at least will be coordinated with all of the following building systems or components:
   1. Fire Suppression Systems.
   2. HVAC, fire, smoke, and combination fire/smoke dampers.
   3. Emergency power systems.
   5. Central Control and Monitoring System.
   7. Gas Detection Systems (future)
   9. Smoke Control Systems (future)

D. Referenced Publications: The documents or portions thereof listed in this section shall be considered part of the requirements of this document. (Utilize latest editions)

1. NFPA 1, Uniform Fire Code
2. NFPA 13, Standard for the Installation of Sprinkler Systems
3. NFPA 14, Standard for the Installation of Standpipe and Hose Systems
4. NFPA 17, Standard for Dry Chemical Extinguishing Systems
5. NFPA 17A, Standard for Wet Chemical Extinguishing Systems
6. NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection
7. NFPA 70, National Electrical Code
8. NFPA 72, National Fire Alarm and Signaling Code
9. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
10. NFPA 92, Standard for Smoke-Control Systems
14. IBC-International Building Code
15. IFC-International Fire Code
16. UL Standard 268, Smoke Detectors for Fire Protective Signaling Systems
17. UL Standard 268A, Smoke Detectors for Duct Application
18. UL Standard 346, Waterflow Indicators for Fire Protective Signaling Systems
20. UL Standard 864, Control Units for Fire Protective Signaling Systems
21. UL Standard 1424, Cables for Power—Limited Fire Protective Signaling Systems
22. UL Standard 1480, Speakers for Fire Protective Signaling Systems
23. UL Standard 1481, Power Supplies for Fire Protective Signaling Systems
24. UL Standard 1711, Amplifiers for Fire Protective Signaling Systems
25. UL Standard 1971, Signaling Devices for the Hearing Impaired
26. UL Standard 2572, Control and Communication Units for Mass Notification Systems
27. ADA-Americans with Disabilities Act
28. TAS-Texas Accessibility Standards
29. American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI):

1.03 Objectives

A. This standard is intended to achieve consistently high levels of fire detection/alarm system performance by:

1. Allowing designers to incorporate required or desired features as early in the design development process as possible.
2. Assuring all systems are designed to meet all applicable codes, ordinances, laws, and sound engineering judgment.
3. Providing a basis for a general understanding among all parties involved in the design of systems.

1.04 Concepts

A. All systems are to be compliant with applicable paragraphs of NFPA 101 "Life Safety Code".

B. All systems are to be compliant with the requirements of NFPA 72 "National Fire Alarm and Signaling Code".

1.05 System Features

A. All system product lines shall be comprised of components capable of providing the following features when appropriate and specified by the project documents or the University:
   1. Floor above/floor below notification.
   2. Private alarm notification.
   3. Positive alarm sequence.
   4. Voice alarm notification.
   5. Fireman's communications.
7. Elevator power shunt trip.
8. Smoke control/fan shutdown.
10. Release locks on normally locked egress doors.
11. Release and monitoring of clean agent and/or pre-action sprinkler systems.
13. Monitor non-water based fire suppression systems.
14. Multiple channel digital voice.

B. Provide audible notification throughout the building in accordance with NFPA 72. Provide an individually silenceable 10 inch, 24 VDC general alarm bell on the building exterior.

C. Visual notification to ADA levels and TAS requirements shall be provided throughout the building.

D. Smoke detectors shall be provided at all elevator lobbies, elevator equipment rooms and elevator hoistways to perform capture/recall functions.

E. All systems shall be designed to provide manual means of alarm initiation at every exit from every level. Elevators are not to be considered an exit or means of egress.

1.06 Description of Work

A. All designs shall provide for each building a complete and working digital, addressable, closed circuit, automatic and manual fire detection / alarm and signaling system for each floor of the building to perform detection, monitoring, signaling and other alarm and control functions for the building.

1.07 Fire Alarm and Signaling System Engineering Documents and Bid Design Documents

A. Approval and Acceptance

1. The Authority Having Jurisdiction (AHJ) shall be notified prior to installation or alteration of equipment or wiring.

2. At the AHJ’s request, complete information regarding the system or system alterations, shall be submitted for approval.

3. Neither approval nor acceptance by the AHJ shall relieve the designer(s) or installer(s) from providing a system compliant with all governing laws, codes or standards.

4. Deviations from requirements of governing laws, codes or standards, shall be clearly identified and documented as such. Documentation of equivalencies shall be provided in accordance with NFPA 72, Section 1.5.
B. Design Documents

1. Prior to installing new systems, replacing an existing system, or upgrading a system, preliminary design documents shall be prepared.

2. Systems that are altered shall have design documents prepared that are applicable to the portion(s) of the system being altered.

3. Preliminary design documents shall contain but not limited to the following information related to the system.
   a. Specifications applicable to the project.
   b. Floor plan scale shall be not smaller than $1/8\text{\,}=1'$ and shall include a bar scale on the respective sheets.
   c. Floor plans shall have building column lines shown and identified.
   d. Fire safety and related symbols shown on drawings and diagrams shall comply with NFPA 170.
   e. When devices are shown on preliminary drawings, the devices shall be located in accordance with standards, listings, and limitations of the equipment specified. When no particular product limitations are specified, the prescriptive criteria of applicable standards shall be used.
   f. Interface between systems such as fire alarm, mass notification, security, HVAC, smoke control, elevators, access control, other fire protection systems, etc.
   g. Input/Output matrix showing sequence of operation between actions.
   h. Survivability of system circuits and equipment.
   i. Input Devices
      i. Automatic smoke detection shall be provided at the location of each fire alarm control unit(s), notification appliance circuit power extenders, and supervising station transmitting equipment to provide notification of fire at that location.
         1. Where ambient conditions prohibit installation of automatic smoke detection, automatic heat detection shall be permitted.
      ii. Manual fire alarm pull stations shall be provided each required exit from every level.
         1. All manual pull stations located in buildings that are used for classes shall have an STI Stopper II or equal.
      iii. The location of detectors used to monitor HVAC systems, close dampers and/or control smoke management systems shall be the sole responsibility of the fire alarm system engineer, and/or preliminary design professional. The engineer, and/or preliminary design professional of fire alarm system shall coordinate with the mechanical engineer to properly locate detectors used to monitor HVAC systems, close dampers and/or control smoke management systems.
j. Audible Notification

i. The ambient sound pressure levels used as a basis for the system design shall be shown on plans.

ii. Acoustically Distinguishable Spaces (ADS) assignments shall be submitted for review and approval.

iii. Each ADS shall be identified as requiring or not requiring voice intelligibility.

iv. ADS measurement points shall be shown on plans or otherwise described in a way that permits future testing at the same locations.

v. Audible notification devices shall have the dB output for each speaker labeled adjacent to the speaker to substantiate the design and assist the installer in sizing amplifiers.

vi. Acoustic properties of spaces and sound loss shall be considered and documented on design drawings with respect to speaker selection and placement to ensure audibility and intelligibility requirements can be met. Acoustical treatments shall include, but not be limited to sound baffles, sound absorption materials, or other such physical treatments to a space.

vii. Achieving intelligibility in certain spaces such as large open or hard surfaced spaces often requires evaluation of the environmental acoustic properties. The burden of audibility and speech intelligibility is frequently placed on the installing fire alarm contractor. However, the contractor has no control over the architectural acoustic aspects of spaces. Therefore, it is essential that the architects and engineers account for the necessary acoustic treatments and intended speaker placement during the physical design of the space.

viii. The architect, engineer, and/or preliminary design professional shall identify the need for, and provide provisions for acoustical treatments required to achieve speech intelligibility.

ix. Average Ambient Sound Level According to Location. The following sound levels shall be used for design purposes.

1. Business occupancies 55 dB
2. Educational occupancies 45 dB
3. Industrial occupancies 80 dB
4. Institutional occupancies 50 dB
5. Mercantile occupancies 40 dB
6. Mechanical rooms 85 dB

7. Piers and water-surrounded structures 40 dB

8. Places of assembly 55 dB

9. Residential occupancies 35 dB

10. Storage occupancies 30 dB

x. In existing facilities the typical average ambient sound levels specified above shall not be used in lieu of actual sound level measurements.

1. The authority having jurisdiction shall be permitted to require actual sound level measurements be taken by an approved independent third party with expertise in audio engineering.

2. The independent third party shall be independent of the Professional Service Provider or design team.

3. All actual sound level measurements shall be performed prior to system design.

k. All control devices utilized for controlling auxiliary functions shall be mounted within 3 feet of the equipment being controlled.

4. Preliminary design documents for smoke management systems shall contain information related to the system which shall include preliminary plans such as those used for bidding or solicitation, specifications, input/output matrix, input device locations, fire department smoke control panel locations, control function locations and graphic panel locations.

C. All designs shall be performed by State of Texas Fire Alarm Planning Superintendent (NICET Level III in Fire Alarm Systems) or by a Professional Engineer (P.E.) registered in Fire Protection in the State of Texas.

1.08 Quality Assurance

A. Fire Alarm Contractor Qualifications:

1. Authorized and designated representative of fire alarm manufacturer to sell, install, and service proposed manufacturer's equipment. The contractor shall have a minimum of 2 factory trained and certified technicians for the system proposed.

2. Licensed by the Texas State Fire Marshal’s Office to sell, install, and service fire alarm systems.

3. Actively engaged in business of selling, installing, and servicing fire alarm systems for at least five years with minimum of ten such installations completed and operating properly.

4. Equipment furnished shall be of current manufacture.

B. Fire Alarm and Signaling System Shop Drawing Designer and System Programmer Qualifications
1. Personnel who are factory trained and certified for fire alarm system design and emergency communications system design and programming of the specific type and brand of system and who are acceptable to the University of Texas Fire Marshal's Office.

2. The design shall be performed by State of Texas Fire Alarm Planning Superintendent (NICET III) or by a Professional Engineer (P.E.) registered in Fire Protection in the State of Texas.

3. The programming shall be performed by individuals complying with one of the following qualifications:
   b. NICET Level II and factory trained and certified for programming of the specific type and brand of system.
   c. Personnel who are factory trained and certified for programming of the specific type and brand of system and who are acceptable to the University of Texas Fire Marshal's Office and the Fire Safety Systems Shop.

4. The system designer and programmer shall provide evidence of their qualifications and/or certifications to the University of Texas Fire Marshal's Office.

5. Shop drawings shall be revised as necessary following installation to represent as-built conditions and include record drawings on all new systems and any system modifications.

C. System Installer
   1. Fire alarm systems and emergency communications systems installation personnel shall be qualified or shall be supervised by persons who are qualified in the installation, inspection, and testing of the systems.
   2. The installation of all fire alarm devices, signaling devices or systems, including monitoring equipment shall be performed by or under the direct supervision of a licensed fire alarm technician or a fire alarm planning superintendent. The certifying licensee shall be licensed under the ACR number of the primary registered firm and shall be present for the final acceptance test prior to certification.
   3. The system installer shall provide evidence of their qualifications and/or certifications to the University of Texas Fire Marshal's Office.

D. The equipment furnished shall be listed and approved by a testing laboratory that have been approved by the State of Texas Commission on Fire Protection. This listing shall be for all functions required by this specification.

E. The Contractor shall provide a signed "Fire Alarm and Emergency Communication System Inspection and Testing Form" for each system, consisting of completed copies of the appropriate pages from NFPA 72, at the final Acceptance Test. The fire alarm
contractor shall attach the appropriate fire alarm tags to the panel as required by the State of Texas.

F. The fire alarm contractor shall provide the Texas Insurance Code Fire Alarm System Installation Inspection Form to the University of Texas Fire Marshal’s Office at the following intervals:
   1. At the completion of the device back-box installation but prior to the start of cable installation;
   2. At the completion of cable installation but prior to the start of device installation; and
   3. At the completion of device installation but prior to activating the fire alarm system.

G. Provide staff installation superintendents who are licensed by the State Fire Marshal’s Office for such purpose and under whose supervision installation, final connections, and testing will be performed.

H. All systems shall comply with applicable paragraphs of the National Electric Code.

1.09 Submittals

A. Prior to installation, the following documents shall be provided to the University of Texas at Austin for reference and/or approval:

1. Shop Drawings: Include manufacturer's name, model numbers, ratings, power requirements, equipment layout, conduit, device arrangement, and complete point to point wiring diagrams along with other required information including but not limited to:
   a) General Drawing Notes
   b) Electrical back box requirements
   c) Control Equipment Schedules
   d) Panel Schematics showing all connections, between modules within panels, to all modules from field wiring with zones identified.
   e) Riser Diagrams indicating circuits, type of devices, number of devices, number of conductors, conduit size, junction boxes, and zones.
   f) Scaled floor plans with layout of all devices with point numbers for initiating and notification devices, wiring connections, zoning, wire sizes and routing.
      I. Wattage setting for each speaker labeled adjacent to the speaker. Candela rating for each strobe labeled adjacent to the strobe.
      II. All new devices, existing devices and devices to be removed shall be shown.
   2. Detailed Legend
   3. Detailed input/output matrix.

B. Product Data: Provide electrical characteristics, connection requirements and compatibility listing showing that components are compatible with each other including but not limited to:
   1. Full equipment list including model numbers and quantities
   2. Complete system operation
   3. Highlighted Data Sheets on Devices and Products a. Fire Alarm Control Panel
28 31 00 - FIRE ALARM AND SIGNALING
DESIGN AND CONSTRUCTION STANDARD

a. Wiring
b. Batteries d. Detectors
c. Manual Stations
d. Audible Signaling Devices
g. Visual Signaling Devices
e. Control Devices
4. Wiring diagrams of all equipment
5. Installation instructions for all equipment
6. Equipment testing procedures
7. Equipment maintenance manuals
8. Wire data sheets.

C. System Calculations - Complete calculations shall be provided which show the electrical load on the following system components (identify all mathematical formulas, variables, and constants used in all calculations):
1. Each system power supply, including stand alone booster supplies
2. Standby Battery Calculations plus a 20 percent de-rating factor
3. Voltage drop calculations for each type of circuit
4. dB loss calculations for speaker circuits
5. Speaker circuit loading and amplifier loading
6. Strobe circuit loading
7. Each auxiliary control circuit that draws power from any system power supply
8. 120VAC power requirement calculations

D. Software and Database Information:
1. Proposed point numbers.
2. Labels of all addressable devices.
3. English action messages.
4. Add Programming rules, Equations, with comments listed.
5. Please send a copy to FSS and PMCS‘ Project Support Fire Protection Engineer.

E. The submittal package shall be signed by the State of Texas Fire Alarm Planning Superintendent (NICET III) or signed and sealed by a Professional Engineer (P.E.) registered in Fire Protection in the State of Texas.
1. All code deficiencies and/or variances shall be noted on the fire alarm submittals and/or drawings.

1.10 Technical Assistance

A. The authority having jurisdiction shall be permitted to require a review by an approved independent third party with expertise in the matter to be reviewed at the submitter’s expense.

B. The independent reviewer shall provide an evaluation and recommend necessary changes of the proposed design, operation, process, or new technology to the authority having jurisdiction.

PART 2 PRODUCTS

2.01 Fire Alarm Control Units (FACU)
A. Acceptable Manufacturers models EST-3, Notifier 3030, Siemens XLSV FIRE FINDER, and Simplex 4100U.

   1. All Fire Alarm System components shall be keyed alike.

B. All fire alarm control units shall be intelligent, addressable Central Processing Units (CPU) based and meets the latest edition of UL 864.

C. All FACUs shall be capable of providing circuit integrity monitoring for all Signaling Line Circuits at a level of Class A, as defined in NFPA 72.

D. All FACUs shall be capable of providing circuit integrity monitoring of Initiating Device Circuits (IDC's) at a level of Class B as defined in NFPA 72.

E. All FACUs shall be capable of providing circuit integrity monitoring of Notification Appliance Circuits (NAC's) at a level of Class B as defined in NFPA 72.

F. Panels shall have provisions for smoke detector "Alarm Verification" for Signaling Line Circuits shall be provided.

G. Manufactured terminal boxes labeled —FIRE ALARM TERMINAL BOX| Space Age TC2 series or equal.

H. With each installed field device affix a label to indicate the devices full address on its signaling line circuit.

I. Mark each cable or wire to designated terminal with labeling tool.

J. All FACUs shall provide twenty percent (20%) excess power supply, input circuit, and output circuit capacity at final acceptance to allow for future expansion by the owner.

K. Zone labeling shall be textual by alpha-numeric display at the FACU and remote annunciator to allow —first response| by persons not trained in fire alarm technology.

L. Textual (alpha-numeric) language shall be conventional, concise, clear and accurate to facilitate rapid response. The label shall contain the device type, floor location, equipment or area served, and an exact device location.

M. All FACUs shall provide a control to bypass the Public Alarm to allow for maintenance and testing, and to reduce disruption.

N. All FACUs shall provide controls to override door holder release, smoke control activation, damper activation, and fan shutdown features to allow for maintenance and testing. Program panel to allow functions to be disabled by floor or by group as required by UT. A means to disable all water flows shall be provided.

O. All FACUs shall be connected to a Primary and Secondary Power source. The secondary power supply shall be sized to provide 5 minutes of operation in alarm conditions after 24
hours of system operation in standby power. Where voice evacuation systems are utilized, 15 minutes of alarm shall be provided.

P. All FACUs shall provide a separate digital address for each initiating device to facilitate rapid response and maintenance and testing.

Q. All FACUs shall provide a separate digital address for each individual flow switch.

R. All programming shall be permanent and non-volatile to reduce outage time due to failure.

S. All FACUs shall provide a panel mounted printer to print a log of all status change activity.

T. All FACUs shall be listed and approved as the smoke detector sensitivity test set to reduce maintenance costs.

U. All FACUs shall be capable of providing drift compensation. Drift compensation is considered equal to adjustability at the detector.

V. All FACUs shall be field programmable, using internal or connected components, for all changes, alterations, modifications, additions, deletions and hardware and software upgrades.

W. All messages shall be recorded in a female voice.

X. All FACUs shall be capable, using internal or connected components, of generating comprehensive reports for sensitivity, verification counts, address registers.

Y. Where a clean agent fire suppression system and/or preaction sprinkler system is specified for the project, the FACU shall be UL listed for releasing service the preaction and/or clean agent system specified in Section 5.21.20. Initiating devices shall be connected to a UL listed releasing panel. All initiating, output and releasing circuits shall reside in one fire alarm control panel.

Z. A fault isolation device shall be provided electrically between each building level. This device shall be capable of automatically isolating wire-to-wire faults on each SLC to the building level involved. The device shall be powered by the SLC loop. The device shall provide visual indication at the device of a short circuit (isolate) condition. The device shall reset to the normal mode upon elimination of the wire-to-wire short. All fault isolation devices shall be physically located within the marshaling box for that floor.

2.02 Remote Monitor

A. All systems shall be capable of interconnection to the Campus-Wide Proprietary Supervisory Signaling System utilizing one set of Form C contacts (one normally open, one normally closed) for transmission of each of the following signals separately:
   1. ALARM
   2. WATERFLOW
3. SUPERVISORY
4. TROUBLE

B. All systems shall provide a Wiring Interface Panel (Space Age TC2 or equivalent) to accommodate the connection between the new fire alarm system and the existing Proprietary Protective Signaling System. The WIP shall be accessible and located within a room that is nearest to the campus utilities tunnel system. Conduit and 18/10 conductor cabling shall be provided between this panel and the FACU to perform the functions listed above. The contractor will be responsible for extending any existing campus monitoring wires when needed to accommodate a new WIP box location.

2.03 Distributed Power Supplies

A. Distributed power supplies for powering Notification Appliance Circuits, beam smoke detectors, and control relays may be used.

B. All distributed power supply inputs shall be controlled by addressable interface devices located on the same floor levels as the power supply and controlled by the SLC serving the area to facilitate maintenance.

C. The distributed power supplies shall be sized to provide 5 minutes of operation in alarm after 24 hours of system operation in standby power. Where voice evacuation systems are utilized, 15 minutes of alarm shall be provided after operation in standby power.

1. The power supplies shall be sized to provide 20 percent spare capacity to accommodate future expansion.

D. The power supplies shall be located in an area that is readily accessible to the fire safety shop and mounted at a height that is easily accessible for regular routine maintenance.

E. All remote power supplies shall be of the same manufacturer as the fire alarm system. All remote power supplies shall also be keyed the same as the fire alarm system.

2.04 Manual Pull Stations

A. All manual pull stations shall be of the "double-action" type to reduce unintentional or vandal alarms. Pull stations required to break glass to activate are not acceptable. Provide pull stations that utilize the same key as FACU for resetting.

B. Each manual pull station shall have a unique digital address on the SLC.

C. Where separate addressable monitor modules are used for monitoring conventional type manual pull stations, the modules are required to be installed within the manual pull station back box.

D. All manual pull stations located in buildings that are used for classes shall have an STI Stopper II or equal.
1. All Stopper II’s shall be 24 VDC powered.
2. The power shall be received from an auxiliary power supply of the same model as those supplied to power the building visual notification.
3. The auxiliary power supply shall be monitored for trouble by the FACU.
4. The 24 VDC power to the Stopper II’s shall not be supervised.
5. The quantity and location of the auxiliary power supplies shall be determined by the engineer or contractor.
6. A smoke detector located at the auxiliary power supply that supplies power to the Stopper II’s is not required.
7. The individual Stopper II’s shall not be monitored by the FACU.
8. Manual pull stations that are protected by Stopper II’s shall be single action.

2.05 Heat Detectors

A. All heat detectors shall be fixed temperature, rate-of-rise, or combination fixed temperature and rate-of-rise, spot type.
B. Each addressable or conventional heat detector shall have a unique address on the SLC.
C. Non resetting detectors shall give visual indication of "ALARM" condition to facilitate rapid response.
D. Where separate addressable monitor modules are used for monitoring conventional type heat detectors, the modules are required to be installed within the heat detector junction box.

2.06 Smoke Detectors

A. All spot type smoke detectors shall be photoelectric or combination photoelectric and ionization type.
B. Each smoke detector, whether spot-type, or projected-beam type, shall have a unique digital address on the SLC.
C. All smoke detectors shall be measurable and adjustable for sensitivity.
D. All smoke detectors, except projected beam type, shall be powered from the SLC.
E. The FACU shall function as the smoke detector sensitivity test set and shall be approved and listed for that service.
F. All smoke detectors shall meet or exceed the requirements of Underwriter's Laboratory Standard 268, as amended, and shall be listed and approved for use with the FACU provided.

2.07 Duct-Mounted Smoke Detectors
A. It is the joint responsibility of the Fire Alarm and the Mechanical Contractors to assure that all supply and return air is sampled as required per NFPA 90A. Label duct work and direction of air flow and identify the proper locations for duct detectors. Provide only addressable system duct detectors, factory installed duct detectors within the air handling unit are not acceptable.

B. ¾ inch armorflex or equal type insulation shall be installed behind all cold deck mounted duct detectors. The insulation shall be sized so that it is a minimum of 3 inches wider than the detector in all directions to allow for sealing the armorflex to the existing insulation.

C. The fire alarm planner/designer shall affix a label at the locations on duct work intended for smoke monitoring in coordination with the mechanical engineer. The label will identify the AHU number, identify if the duct is for supply or return air, and the direction of the airflow in the duct.

2.08 Projected-Beam Smoke Detectors

A. All projected-beam detectors shall operate on the infrared principle.
B. All projected-beam detectors shall have automatic gain control circuits to compensate for deterioration of signal strength due to environmental factors such as dirt and dust accumulation, component aging and temperature fluctuations.
C. Transmitting and receiving units of projected-beam detectors shall be protected from physical damage.
D. All projected-beam smoke detectors shall have circuits to prevent "false" alarms due to sudden and complete obscuration.
E. Written AHJ approval will be required for the installation of beam smoke detectors.

2.09 Air Sampling Smoke Detection

A. Provide air sampling smoke detection system if required by the project.
B. Locate air sampling ports in accordance with NFPA 72 and manufacturer’s requirements.
C. Maintain a maximum transport time of 120 seconds, or the transport time specified by the manufacturer, from the farthest sampling point, whichever is less.
D. Utilize CPVC piping that is listed for use in air sampling systems. Label piping as required per NFPA 72.
E. Air sampling system power supplies shall be monitored for any impairment and shall all be keyed alike to FACU. The power supplies shall be of the same manufacturer as the sampling system unless otherwise specified in the manufacturer’s documentation.
F. Any impairment of the air sampling system shall report to the building fire alarm system.

2.10 Waterflow Switches

A. Fire detection/signaling systems shall be interconnected to the fire sprinkler systems. Waterflow switches shall be set for a 60 second or greater delay/retard not to exceed 90 seconds prior to the "ALARM".
B. Each waterflow switch shall be monitored with a unique digital address on the SLC.

C. It is the responsibility of the Sprinkler Contractor to locate the waterflow switches to assure indication of water flow within the building and at each level of the building to reduce water damage.

2.11 Supervisory (Tamper) Switches

A. Connect tamper switches installed on all sprinkler or standpipe system valves to the fire alarm system to indicate closing or opening of the valves.

B. Each tamper switch shall be monitored with a unique digital address on the SLC.

2.12 Audible Appliances

A. Fire alarm system audible notification is required to be provided by speakers in all buildings. The fire alarm signal generated shall be the distinctive three-pulse temporal pattern described by NFPA 72 and ANSI codes.

B. The Evacuation Signal produced by the speakers shall be alternated with a custom textual message as indicated in Section 3.07 below.

C. Provide audible systems with voice intelligibility measured in accordance with the guidelines in Annex A of IEC 60849, Sound Systems for Emergency Purposes. When tested in accordance with Annex B, Clause B1, of IEC 60849, the system shall considered acceptable if at least 90 percent of the measurement locations within each area have a measured STI of not less than 0.45 (0.65 CIS) and an average STI of not less than 0.50 STI (0.70 CIS).

2.13 Visual Appliances

A. All visual notification appliances shall be xenon strobe, compliant with current requirements of ADA and TAS.

B. All visual notification devices within a room or adjacent space within the field of view shall be synchronized as required per NFPA 72.

C. Strobes shall be clear or nominal while meeting the listing requirements of UL 1971 and either have no marking or be marked with the word —ALERT— stamped or imprinted on the appliance and be visible to the public.

2.14 Remote Annunciator

A. When required by the project, an LCD remote annunciator shall be located in an open accessible area at or adjacent to the main ground level entrance to the building. The FACU may then be located in a remote location or room.

B. Remote annunciator must display the same addressable and common signal information as the main FACU.

2.15 Monitoring Devices
A. Addressable monitoring devices used to monitor contact-closure initiating devices such as waterflow switches, and tamper switches shall derive power from the SLC to which they are connected.

B. Each monitoring device shall have a unique digital address on the SLC.

2.16 Control Devices

A. Addressable control devices shall not control more than one type of appliance/device.

B. SLC form_Cl Relay shall be rated for the load. Interposing relays are not allowed.

2.17 Documentation Storage

A. Storage cabinet shall be provided at or adjacent to (within five feet of) the FACU. This cabinet shall be a Space Age DBXA or equal 64 and capable of storing and securing all documents required for system maintenance and response. Storage shall be separated from all active electrical, electronic, or electromechanical parts and components. If adequate, storage may contain unconnected spare/repair parts.

2.18 Remote Microphone

A. Remote microphones shall be installed at all new and existing FACU’s with voice capabilities on the campus of the University of Texas at Austin as an ancillary function. The remote microphone shall be installed within five feet of the Fire Alarm Control Units or within five feet of the Fire Command Center outside of any locked rooms. The remote microphone shall provide Building Managers with a simple means to activate —All EVACS SPEAKERS!. Visual notification shall not activate upon the activation of the remote microphone. Any fire alarm signal shall take precedence over the remote microphone use and the remote microphone shall be rendered inoperable. The remote microphone shall have a lower priority and shall not interfere with the performance requirements of the fire alarm system or mass notification system. The Remote Microphone shall be in a locked enclosure (key to be specified).

B. Remote Microphone shall consist of the following features:
   1. A supervised keyed microphone handset.
   2. Surface mounted lockable cabinet.
   3. Lock shall be keyed differently than the Fire Alarm Control Unit (FACU).
   4. Power On LED.
   5. Trouble LED.
   6. Ready or Active LED indicators

PART 3 INTERCONNECTION AND OPERATION

3.01 Signaling Line Circuits (SLC)

A. All FACUs shall provide circuit integrity monitoring for all Signaling Line Circuits at a level of Class A serving no more than 3 levels with short isolators in place for each level.
B. All the following devices/appliances shall be individually addressed on the SLC:
   1. Smoke detectors.
   2. Heat detectors.
   5. Control devices.
   6. IDCs.
   7. Audio NACs.
   8. Visual NACs.

3.02 Initiating Device Circuits (IDC)

A. Initiating Device Circuits (IDCs) shall be monitored at a level of Class B.

3.03 Notification Appliance Circuits (NAC)

A. All Notification Appliance Circuits (NACs) shall be monitored at a level of Class B.

B. Direct current notification appliance power provided from a distributed power supply shall be controlled by a digital addressable control device on the SLC.

3.04 Auxiliary Functions

A. Locate control devices utilized for operating auxiliary functions mounted within 3 feet of the equipment being controlled as required per NFPA 72.

3.05 Floor Above/Floor Below Notification

A. Selective evacuation shall be permitted if approved by the AHJ.

B. In high rise structures, each level shall constitute a minimum of one audio Notification Appliance Circuit and one visual Notification Appliance Circuit. NACs shall be capable of initiating a general alarm or allow selectable notification.

C. The FACU shall also provide a control at the panel to allow sounding the Public Alarm throughout the structure (All-call) and activate both audio and visual notification for building evacuation at the FACU.

3.06 Positive Alarm Sequence

A. Positive alarm sequencing shall be permitted if approved by the AHJ.

3.07 Voice Alarm Notification

A. Provide speakers for annunciation of voice messages. Signals generated shall be the Distinctive Evacuation Signal (three-pulse temporal pattern) alternated with the custom message listed below in 3.07dB in a female voice.

B. Audible message required for voice evacuation shall be as follows:
1. "Attention, please! Attention, please! An emergency situation has been detected in the building. Please evacuate immediately in accordance with safety and security regulations. Use stairwells; do NOT use elevators. Repeat: use stairwells; do NOT use elevators. Go to your assigned area outside the building or follow the instructions of the staff or emergency personnel. Do not re-enter the building until instructed to do so by emergency personnel. Please evacuate the building immediately."

C. Digitized audible evacuation messages shall sound once and shall be preceded by a minimum of two cycles of the three pulse temporal pattern emergency evacuation signal.
D. The FACU shall provide a microphone and associated controls to allow voice paging to selected areas.

3.08 Fire Department Communication System

A. Where required by code, provide a complete and separate two-way fire department communication system.
B. Electrically supervised two way fireman's phone jacks shall be provided at the entrance to all elevators, enclosed stairwells, elevator lobbies, emergency and standby power rooms. Phone jacks are also required in fire pump rooms and fire command centers, where provided.
C. Wiring for the Fireman's Communications System may be installed in common raceway or conduit utilized by the fire alarm system.
D. Provide an adequate number of handsets and a storage cabinet to hold the handsets when not in use at the fire alarm control panel.

3.09 Elevator Recall

A. Provide elevator recall in accordance with ASME A17.1, ASME A17.3, elevator manufacturer's instructions, and NFPA 72.

3.10 Fan Shutdown, Dampers, and Smoke Control

A. Duct-mounted smoke detectors shall cause shutdown of associated air handling units and report a supervisory signal to the fire alarm control panel. 120 VAC power circuits shall not be routed through the housing.
B. The SLC shall connect to a control device within three feet of the motor starter or other approved location to interrupt the motor control circuits.
C. Smoke detectors for damper control shall be located within 5 feet of the damper.
D. Damper controls shall have separate control relays external of the duct detector. The SLC form —C1 Relay contacts shall be rated for the load. Additional interposing relays are not allowed.

1. Where a smoke control system is provided, connect FACU to smoke control panel using form C relays for initiation of smoke control system and associated dampers in
accordance with NFPA 92. The smoke control panel, provided by others, is required to comply with UL 864 and listed as smoke control equipment.

2. Provide individual supervised —Service Switches or Software Zonesl to bypass Fan Shutdown, Damper Control, Smoke Control, and Stair Pressurization. A trouble shall be posted on the FACU when a bypass condition is active.

3.11 Automatic Door Control

A. Automatic Release-to-Close
   1. Smoke control doors normally held open electrically shall be allowed to close upon any "ALARM" condition.

B. Automatic Unlock
   1. Access control doors normally electrically locked for security shall unlock on any "ALARM" condition.
   2. Provide UT card access control for the Fire Command Center that will unlock on FIRE.

3.12 Wiring

A. Basic wiring materials and installation shall comply with NFPA 70.

B. Conductor sizes shall be sized in accordance with NFPA 72 and NFPA 70 to provide the minimum required voltage drop.

C. Install wiring in conduit or raceway where required per NFPA 70.

D. All system wiring shall be color coded in accordance with the following:
   1. Power circuits - Black
   2. Strobe circuits - Yellow or White
   3. One way voice speakers – Blue
   4. Signaling line circuits, initiating device circuits, network communications cable – Red
   5. Grounding conductor – Green
      a. Main Floor Recall - Red
      b. Alternate Floor Recall - Blue
      c. Fire Hat Signal - Yellow
      d. Supply power - Black

E. Circuits extending beyond buildings
   1. Where circuits are required to extend outside of the building, wiring shall be provided with primary protectors in accordance with NFPA 70 Article 760 and Article 800.

PART 4 SPECIAL CONDITIONS

4.01 General
A. It is the responsibility of the Contractor to assure that there is no disruption of the University's normal functions during construction such as studying, testing, class, research or administration.

4.02 Connecting to or Modifying Existing Systems

A. Operating, modifying, and connecting to existing fire alarm systems shall be supervised and/or coordinated by the University of Texas at Austin Fire Safety Systems Shop (FSSS) staff. Documentation indicating all changes shall be provided at the FACU at the time changes are made.

B. Existing systems shall remain operational during modifications or additions to the existing system throughout the duration of the project.

C. Where part or all of the existing fire alarm system is required to be demolished, remove the existing fire alarm components only after the new system installation is complete and accepted by FSSS and FPS.

D. Existing equipment that is required to be salvaged by the University shall be stored in a secure area designated by the University.

4.03 Preaction and Clean Agent Releasing Systems

A. Where the project requires releasing of a preaction and/or clean agent system, the room or area in which the suppression system is located shall utilize two separate smoke detectors or activation of a manual release station to activate the suppression system.

B. Reduce smoke detector spacing for rooms or areas utilizing high airflow as required per NFPA 72.

C. If a separate Suppression FACU is installed, it shall be intelligent, listed for the release application, and of the same manufacturer as the building fire alarm system, unless specifically authorized by the AHJ.

4.04 Smoke Control System

A. Where a smoke control system is required for the project, connect FACU to smoke control panel for initiation of smoke control and associated dampers upon activation of sprinkler system water flow switch and/or a total coverage smoke detection system located within the area requiring smoke control. The smoke control panel, provided by others, is required to comply with UL 864 and listed as smoke control equipment. Where a smoke control system is required, the FACU shall provide the relay interface to a separate smoke control panel of the same model and manufacturer as the FACU.

B. The Smoke Control panel shall be listed in accordance with UL 864 as smoke control equipment.
C. Provide control relay for Facilities Monitoring that activates on any AHU control, Damper control, Smoke control, and Stair pressurization control event at the FACU or designated Mechanical room.

4.05 Mass Notification System

A. Include the additional equipment required to connect to the future campus wide mass notification system. Fire alarm speakers and speaker/strobes will be utilized for the audible portion of the mass notification system. Coordinate with UT for additional requirements involving equipment and connection to mass notification system.

B. The FACU shall be capable of generating a Slow Whoop pre-tone for future Mass Notification.

4.06 Third Party Fire Alarm Monitoring

A. This procedure applies to temporary third party monitoring of fire alarm control unit signals when contract personnel are responsible for emergency response. It defines the actions and responsibilities that shall be adhered to by UT personnel and contract personnel when responding to fire alarm panel signals.

B. Purpose

1. The purpose of this document is to specify the responsibilities and steps required for contractors to respond to Trouble, Supervisory or Alarm signals from fire alarm panels. It applies when building fire systems, or portions of systems, are not the responsibility of the Fire Safety Systems Shop (FSSS), but require monitoring, response to signals, and resolution of problems by contractors.

2. For every new construction or renovation project, either the FSSS or the contractor will be responsible for providing a responding technician to Fire Alarm Signals throughout the project. The decision as to who maintains responsibility is made as early in the project timeline as possible, typically at 60% design review but always before construction begins. The scope of the project and extent of impact on fire systems influence this decision. The decision shall be made on a case-by-case basis for each project as an agreement between the UT Police Department (UTPD) and the FSSS and shall be clearly communicated to the Project Manager. This procedure applies when the contractor is the responsible party, or when a contractor takes responsibility for a fire system for any reason.

C. Definitions

1. Fire Alarm - The highest priority on a fire alarm panel indicating that a smoke detector, heat detector, manual pull station or water flow switch has been activated. The alarm system will be in full activation including audio, visual and emergency notifications. The monitoring company will receive the alarm and immediately notify
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the Austin Fire Department (AFD). The panel will have to be reset after an all clear is given by the AFD.

2. Supervisory Signal - The second highest priority on the fire alarm panel indicating that one or more critical fire protection devices is indicating a problem with the input circuit. This could result from a number of causes such as a sprinkler tamper switch or a smoke detector. A local panel alarm will sound and the monitoring company will receive a Supervisory Signal. The fire department will not be called, but a qualified on-call contractor representative will be contacted and shall respond. The panel will have to be reset once the problem is identified.

3. This is the lowest priority on the system and indicates an electrical or device malfunction such as a wiring fault, phone line problem, or device problem. A local panel alarm will sound and the monitoring company will receive a Trouble Signal. The fire department will not be called, but a qualified on-call contractor will be contacted and must respond. The panel will have to be reset once the problem is identified.

D. Requirements

1. When the fire alarm system is turned over to the Contractor by the Fire Safety Systems Shop:
   a. Contractor provides two operational phone lines and ensures that 120 VAC is available at the Fire Alarm Control Unit (FACU).
   b. Contractor ensures that there is a fully operational Digital Alarm Communicator Transmitter (DACT) with their monitoring service.
   c. Contractor provides 24-hour advance notice to the FSSS to witness the transmission and receipt of Trouble, Supervisory and Alarm signals.
   d. After successful witness of signal transmission and receipt, the FSSS removes the campus-wide monitoring connection from the FACU.
   e. The Project Manager sends out notification to all appropriate University and Contractor personnel including FPS, UTPD and Facilities Monitoring stating that the Contractor is fully responsible for operation of the system and reporting and notification of signals per this specification

2. On any automatic Fire Alarm or Water Flow alarm
   a. First, the monitoring company is to call AFD.
      i. They shall give the name and address of the building.
   b. Second, the monitoring company is to call UTPD.
i. They shall give the name and address of the building.

c. Third, the monitoring company is to call the responding technician.

   i. They shall give the name and address of the building.

   ii. The responding technician shall to arrive at the fire alarm panel location within 2 hours after receipt of a call.

   iii. After receiving a call from the monitoring company, the responding technician shall call Facilities Monitoring to inform them of their estimated time of arrival.

   d. Facilities Monitoring Operators shall log the estimated responding technician’s time of arrival.

   iv. Upon arrival, the responding technician shall report to Facilities Monitoring and sign in.

   v. Upon completion of work, the responding technician shall report to Facilities Monitoring, brief them on the status of the fire alarm system, and sign out.

e. Fourth the monitoring company is to call Facilities Monitoring

   i. They shall give the name and address of the building and verify that AFD, UTPD and the responding technician were contacted successfully.

   f. Facilities Monitoring Operators shall log the information received.

3. On any Supervisory Signal

   a. First, the monitoring company is to call the responding technician.

      i. They shall give the name and address of the building.

      ii. The responding technician shall to arrive at the fire alarm panel location within 2 hours after receipt of a call.

      iii. After receiving a call from the monitoring company, responding technician shall call Facilities Monitoring to inform them of their estimated time of arrival.

   b. Facilities Monitoring Operators shall log the estimated time of arrival of the responding technician.

      iv. Upon arrival, the responding technician shall report to Facilities Monitoring and sign in.
v. Upon completion of work, the responding technician shall report to Facilities Monitoring, brief them on the status of the fire alarm system, and sign out.

c. Second, the monitoring company is to call Facilities Monitoring.
   i. They shall give the name, address of the building, and verify that the responding technician was contacted successfully.

d. Facilities Monitoring Operators shall log the information received.

4. On any Trouble Signal

a. First, the monitoring company is to call the responding technician.

i. They shall give the name and address of the building.
ii. The responding technician shall arrive at the fire alarm panel location within 4 hours after receipt of a call.
iii. After receiving a call from the monitoring company, the responding technician shall call Facilities Monitoring to inform them of their estimated time of arrival.
iv. Facilities Monitoring Operators shall log the estimated time of arrival of the responding technician.
v. Upon arrival, the responding technician shall report to Facilities Monitoring and sign in.
vi. Upon completion of work, the responding technician shall report to Facilities Monitoring, brief them on the status of the fire alarm system, and sign out.

b. Second, the monitoring company is to call Facilities Monitoring.
   i. They shall give the name, address of the building, and verify that the responding technician was contacted successfully.

c. Facilities Monitoring Operators shall log the information received.

4.07 Silencing Fire Alarms During Construction and Testing in Existing Buildings

A. Contractors may silence alarms during fire alarm installation and testing only on floors, areas or any part of a building that has not been commissioned and turned over to the University.

B. The contractor shall cease all work and/or testing and investigate the cause of the alarm.

C. Contractors shall notify the proprietary central monitoring station and/or UTPD and Fire Safety Systems Shop immediately after the alarm investigation in buildings that have reporting capabilities that the alarm is false.

D. Simultaneously with central monitoring station and/or UTPD and Fire Safety Systems Shop notification, the building occupants shall be notified of the false alarm.
E. The contractor shall fill out a detail report of the cause of the false alarm. The report shall include, but not limited to alarm cause, alarm time, location, persons involved and corrective actions.

F. Contractors shall **not** silence alarms on floors, areas or any part of a building that has been commissioned and turned over to the University.

4.08 Fire Watch

A. Where a required fire alarm system is out of service for more than 4 hours in a 24-hour period, FPS shall be notified, the building shall be evacuated, or an approved fire watch shall be provided for all parties left unprotected by the shutdown; until the fire alarm system and/or automatic sprinkler system has been returned to service.

B. The fire watch shall be performed for the entire duration of the outage. This includes lunches, breaks, and any lag time between the completion of work and the system restoration.

   1. All areas of the affected area shall be surveyed a minimum every thirty minutes.

C. One person or several people can perform the fire watch and if all areas without sprinkler and/or fire alarm coverage are occupied with workers, the group can perform the fire watch. At least one individual involved in the fire watch shall be provided as the primary contact and the fire watch shall involve some special action beyond normal staffing, such as assigning additional personnel to walk the areas affected. Such individuals shall be specially trained in fire prevention and in the use of fire extinguishers, in notifying UTPD, in sounding the building fire alarm, and in understanding the particular fire safety situation for public education purposes.

   1. Although a group of workers are allowed to be the fire watch; the entire group shall receive fire watch instructions and at least one person shall perform a survey over the entire area affected by the outage or shutdown every 30 minutes and 30 minutes after work is completed.

D. The following is the required minimum knowledge of the fire alarm and sprinkler system to perform a fire watch:

   1. At what frequency is the fire watch to be performed?
      a. Answer - Minimum every thirty minutes.

   2. How long after work has been completed and the system restored is the fire watch required to be continued.
      a. Answer - Thirty minutes.
3. The person or persons responsible for the fire watch shall know the location of the sprinkler control valves and know how to charge the sprinkler system and shall explain this, a minimum of one time per individual performing the fire watch.

4. The person or persons responsible for the fire watch shall know the location of all manual pull station within the affected area and know how to activate the pull station and shall explain this, a minimum of one time per individual performing the fire watch.

5. The person or persons responsible for the fire watch shall have the ability to contact UTPD in the event of a fire emergency and have a means of contacting UTPD on a cellular phone.

E. All manual pull stations in the fire watch area shall remain active for the duration of the fire watch.

F. Fire watch personnel shall watch for fires in all exposed areas. If a fire is located, fire watch personnel shall perform the following and shall explain these procedures in sequence when quizzed by FPS staff:

1. Sound the building fire alarm immediately by pulling a manual pull station.

2. Report the fire or other emergencies to UTPD by phone (471-4441).
   a. Inform UTPD of the building and the floor of the fire emergency.

3. Try to extinguish the fire only when obviously within the capacity of the equipment available.

G. The fire watch personnel shall have a minimum 10LB 4-A: 40B: C fire extinguisher on their person while performing the fire watch.

H. Remove any covers from sprinkler heads immediately upon completion of work, if applicable.

I. Remove covers from any smoke detectors immediately upon completion of work, if applicable.

J. The fire watch shall be permitted to perform additional tasks, but those tasks shall not distract him or her from his or her fire watch responsibilities.

K. The fire watch shall be maintained for at least 30 minutes after completion of cutting, welding, or other open flame operations to detect and extinguish smoldering and flaming fires. During this time, the work area and other adjacent areas where sparks or flame may have traveled are to be searched for signs of combustion.
L. FPS will have inspectors periodically visit the job sight and verify the fire watch. The person or persons performing the fire watch shall answer questions regarding the fire watch procedure.

M. If the responsible fire watch personnel fail to answer all questions correctly regarding the fire watch procedure, the project will be shut down immediately and the fire alarm system or automatic sprinkler system restored without delay.

4.09 Smoke Detector Protection During Construction

GENERAL: Construction debris, dust (especially gypsum dust and the fines resulting from the sanding of drywall joint compounds), and aerosols can affect the sensitivity of smoke detectors and, in some instances, cause deleterious effects to the detector, thereby significantly reducing the expected life of the detector.

Many smoke detectors are shipped with a thin plastic cover over the sensing portion of the detector. It is widely assumed that these covers are suitable for protecting the detector from construction dust, dirt, and debris. In actuality, most of the "covers" supplied are merely for shipping and are not intended to be used in lieu of proper protection from construction debris. These covers cannot be relied on to keep the detector entirely free of contaminants.

A. Where smoke detectors were previously installed and remain operational during construction, they shall be protected from construction debris, dust, dirt, and damage in accordance with the manufacturer's recommendations. Prior to protecting and/or covering any smoke detector, the contractor shall provide FPS and FSSS copies of the sensitivity measurement for each detector to be affected. At the time of completed construction, a sensitivity measurement shall be performed. The contractor shall provide FPS and FSSS copies of the sensitivity measurement for each smoke detector after all construction trades have finished their work. If the detectors are greater than 1% of the starting obscuration, the detectors shall be cleaned and verified to be operating in accordance with the listed sensitivity, or they shall be replaced.

B. Where smoke detectors were previously installed but not operational during construction, they shall be protected from construction debris, dust, dirt, and damage in accordance with the manufacturer's recommendations. Prior to protecting and/or covering any smoke detector, the contractor shall provide FPS and FSSS copies of the sensitivity measurement for each detector to be affected. At the time of completed construction, a sensitivity measurement shall be performed. If the detectors are greater than 1% of the starting obscuration, the detectors shall be cleaned and verified to be operating in accordance with the listed sensitivity, or they shall be replaced.

C. In new construction, if detectors are installed before completion of construction cleanup, they must be protected in accordance with the manufacturer's recommendations. After the construction cleanup is performed, a sensitivity measurement shall be performed. The detectors shall be cleaned and verified to be operating in accordance with the listed sensitivity, or they shall be replaced.
D. Prior to protecting and/or covering any smoke detector, the contractor shall perform an outage request. The completed request shall be received twenty-four (24) hours prior to the outage date requested. A factory-trained technician of the manufacturer of the fire alarm system shall perform the protecting and/or covering of any smoke detector. The outage request shall contain the following:

1. The beginning date and time, the smoke detectors are to be protected and/or covered.
2. A scaled drawing showing the smoke detectors that are to be protected and/or covered.
3. The ending date and time, the smoke detectors are to be protected and/or covered.

E. The contractor shall provide FPS and FSSS copies of the sensitivity measurement for each smoke detector after all construction trades have finished their work.

F. The contractor shall schedule site survey to verify the detector protection has been removed.

PART 5 TESTING

5.01 General

A. Upon completion of the system, the Fire Alarm Contractor shall perform a complete and comprehensive test of the entire system in accordance with the provisions of NFPA 72. The Fire Alarm Contractor shall document their testing electronically using logging software commonly available.

B. It is the responsibility of the Fire Alarm Contractor to demonstrate to the University that the system is installed and functions in accordance with the project documents and applicable codes.

5.02 Specific Tests

A. An acceptance test will be conducted at the completion of each project. The test will be the responsibility of the Fire Alarm Contractor and shall be performed in strict compliance with the provisions of NFPA 72.

B. In addition to the provisions of NFPA 72 and/or the above paragraph, it is the responsibility of the Fire Alarm Contractor to provide all of the following:
   1. Smoke detector sensitivity report.
   2. Pressure differential readings for duct detector sample air flow.
   3. Closed loop resistance and EOL resistance readings for all field wiring.
   4. Provide field dB measurements on as-built drawings.

C. Third Party Testing:
1. Third Party testing shall be conducted by an independent third party, who shall be
independent of the Professional Service Provider or design team companies, reporting
to and approved by the Owner. Third Party testing shall include repeating all of the
tests described in ―Fire Alarm Contractor's Test‖ above. A detailed listing of any
deficiencies found during these tests shall be forwarded to the Fire Alarm Contractor
and shall serve as a punch—list for the system.

2. All witness testing shall be performed by State of Texas Fire Alarm Planning
Superintendent (NICET Level III in Fire Alarm Systems) or by a Professional
Engineer (P.E.) registered in Fire Protection in the State of Texas.

3. The Campus may, at its sole option, witness and/or participate in any and all tests.

4. If, at any point during their tests, the Third Party finds significant deficiencies they
are to report those to the Owner who will then determine an appropriate course of
action. If the Owner determines that, the number and/or severity of the deficiencies so
justify, they may stop the Third Party Testing and instruct the Fire Alarm Contractor
to correct the deficiencies and re-certify the system. Such retesting shall include
Supervision testing of 100% of the Initiating Device Circuits, Notification Appliance
Circuits, and Signaling Line Circuits.

5. If retesting by the Third Party is required due to significant deficiencies in the work
of the Contractor, the Contractor shall reimburse the Owner for the cost of the Third
Party Tests conducted to that point.

D. Fix Deficiencies:
   1. A copy of the formatted check list shall be transmitted to the contractor to serve as a
      punch out list for the correction of the noted deficiencies, The Contractor shall notify
      the verifying party in writing that the deficiencies have been corrected along with a
      copy of the punch out list with the corrected deficiencies initialed by the Contractor
      to indicate the corrections.

   2. The Fire Alarm Contractor shall provide updated certification forms as set forth in
      Section II Certification of this document.

E. Third Party Retest:
   1. Each deficient item shall be retested. Retesting of the system shall be conducted in
      accordance with NFPA 72, Table 14.4.2.2, Test Methods. If any software changes are
      made to the system updated site-specific software print out with all changes
      highlighted will be submitted to the verifying party prior to the start of retesting.

F. Third Party Certification:
   1. The Third Party shall then retest each portion of the system affected by the
corrections. If no additional deficiencies are found, the Third Party shall issue a
      ―Third Party Certification‖ stating that they have tested the system and certify that it
      complies with the appropriate sections of NFPA 72. Such certification shall not
      contain any disclaimers or similar comments.

G. Campus Test and Acceptance:
   1. Upon receipt of all documents from the final —Fire Alarm Contractor's Certification‖
      and the —Third Party Certification‖ the Campus will conduct any tests it determines
      to be necessary, consistent with the specified survivability style and performance
      requirements for the system. If no additional deficiencies are found, they will accept
      the system. If additional deficiencies are found, the Contractor will be required to
correct the deficiencies, re-test and re-certify the system. Such re-testing shall include Supervision testing of 100% of the Initiating Device Circuits, Notification Appliance Circuits, and Signaling Line Circuits. The Third Party shall then re-tests each portion of the system affected by the corrections; If no additional deficiencies are found. The Third Party shall re-issue a —Third Party Certification as set forth in Section —Fire Third Party Certification of this document.

H. Fire Alarm Testing Overview:
   1. Reference:

Fire Alarm System Testing Overview

<table>
<thead>
<tr>
<th>Contractor’s Test</th>
<th>General Contractor</th>
<th>OFPC</th>
<th>3rd Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>II. Contractor's Certification</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

IV. Fix Deficiencies
   X

V. 3rd Party Retest
   X
   X
   X

VI. 3rd Party Certification
   X

VIII. Campus Test
   X*
   X*
   X

and Acceptance

Note: The Campus may, at its sole option, require the assistance and/or participation of the contractor in this testing.

5.03 Testing and Measurements within an Acoustical Distinguishable Space

A. Measurements shall be taken at an elevation of 5 ft (1.5 m) or at any other elevation deemed appropriate if the area is subject to normal occupant access (e.g., elevated walkways).

B. The number and location of measurement points in each ADS shall be planned and based on the area and volume of the space and the speaker appliance location within the space. The location of noise sources, egress paths, and the locations of personnel in the space shall also be considered.

C. If multiple measurement points are required within an ADS, they shall be separated by about 40 ft (12.2 m).

D. No more than one third of the measurement points within an ADS shall be on the axis of a speaker.

E. The intelligibility of an emergency communication system is considered acceptable if at least 90 percent of the measurement locations within each ADS have a measured STI of not less than 0.45 (0.65 CIS) and an average STI of not less than 0.50 STI (0.70 CIS).
F. Measurements should be made and recorded using two decimal places. Averages can be calculated to three decimal points and rounded.

G. Occupied Testing
   1. Testing should be done during a period of time when the area is occupied and is reasonably close to having maximum background noise.
   2. At each measurement point in each ADS measure the STI or CIS.
   3. Average the results at different measurement points within the ADS.
   4. Document the results on plans or forms in a way that accurately describes the measurement point and that permits future testing at the same locations.

H. Unoccupied Testing
   1. This test method requires three different measurements at each measurement point, typically made during two site visits. The data for each measurement is saved in a format in accordance with the instrument manufacturer's requirements. The three data files are then post-processed to arrive at the final corrected STI OR CIS.
   2. Unoccupied Ambient Sound Pressure Level Measurement
      a. At each measurement point in each ADS measure the unoccupied ambient sound pressure level.
      b. Save the measurement data in accordance with the instrument manufacturer's requirements to permit post-processing of the data.
      c. Document the results in writing on plans or forms in a way that accurately describes the measurement point and that permits future testing at the same locations.
   3. Unoccupied STI or CIS Measurement
      a. At each measurement point in each ADS measure the uncorrected STI or CIS.
      b. Document the results in writing on plans or forms in a way that accurately describes the measurement point and that permits future testing at the same locations.
   4. Occupied Ambient Sound Pressure Level Measurement
      a. At each measurement point in each ADS measure the occupied ambient sound pressure level.
      b. Save the measurement data in accordance with the instrument manufacturer's requirements to permit post-processing of the data.
      c. Document the results in writing on plans or forms in a way that accurately describes the measurement point and that permits future testing at the same locations.
   5. Post Processing
      a. The corrected STI or CIS is arrived by post-processing of the occupied ambient sound pressure level measurement, the unoccupied ambient sound pressure level measurement, and the unoccupied STI or CIS measurement. In effect, the measured STI or CIS (uncorrected) is being corrected by adding in the effects the actual expected (occupied) ambient sound pressure level.
      b. The post processing procedure or software provided by the instrument manufacturer should be used to calculate the final corrected STI or CIS for each measurement point.
PART 6 DOCUMENTATION

6.01 General

A. A documentation package shall be provided by the Contractor before final testing with FSSS and FPS AHJ that shall include all information needed to allow the University to perform additions, modifications, maintenance and repair of the system.

B. This shall include:
   1. Equipment schematic diagrams for all components and modules.
   2. Equipment technical data.
   3. Field device address register.
   4. Equipment repair parts lists.
   5. Programming disk with all system software required for a re-start after traumatic failure. Software shall be of appropriate and compatible update version for the firmware installed including hardware key, if required.

C. "As-built" wiring, conduit diagrams to include:
   1. Floor plan layout drawings showing all significant conduit routes and sizes, wire amounts, sizes and color code and marshaling box locations.
   2. Riser diagram showing all significant conduit routes and sizes, wire amounts, sizes and color code and marshaling box locations.

D. Floor plan device layout drawing to include:
   1. All initiating device locations and digital addresses.
   2. All notification appliance locations and NAC digital addresses or device number.
   3. All control device locations and digital addresses.
   4. All monitor device locations for supervisory switch groups.
   5. All distributed power supply locations and digital addresses.
   6. Schematic representation of all SLCs, NACs, control circuits, audio circuits and power circuits.

E. Riser diagram to include:
   1. All initiating devices with their electrical location and digital address on the SLC.
   2. All notification appliances with their electrical location and device number or digital address on the SLC.
   3. All control devices with their electrical location and digital address on the SLC.
   4. All supervisory switch locations and their interconnection to the monitor device (IDCs).
   5. All monitor devices with their electrical location and digital address on the SLC.
6. All distributed power supplies with their associated wiring and digital address(es) on the SLC.
7. Schematic representation of all SLCs, NACs, audio circuits and power circuits.

F. Interconnection diagram(s) for all internal components of the Fire Alarm Control Panel, including switch settings, jumpers, module addresses, and Terminations on drawings.

G. State of Texas or NFPA certification form.

H. Programming guide for the functional programming to provide for field changes to the zone schedule or other operational features.

I. Backup copy of the operating system and/or all resident programming, software or firmware, which would be required to restore the system to full operation after a complete failure or equipment replacement including any security device needed to run the system software.

J. On new building construction projects, provide a Laptop with all cables and software installed necessary to restore the system to normal in event of a catastrophic failure.

K. Provide factory logging software for periodic testing.

L. System to be tagged and certificate of registration posted at FACU.

6.02 Speech Intelligibility Documentation

A. The speech intelligibility test results should be fully documented and provided to the Fire Safety Systems Shop and Fire Prevention Services.

B. In addition to the requirements for test documentation contained in NFPA 72 Chapter 14, the test results should include:
   1. Building location and related descriptive facility information
   2. Names, titles, and contact information for individuals involved in test
   3. Dates and times of tests
   4. A list of testing instruments, including manufacturer’s name, model, serial number, and date of most recent calibration
   5. Technical description of emergency communications system
   6. Identification of ADS
   7. Locations of specific measurement points (in a list or on a set of drawings)
   8. Site definition of ambient sound pressure levels
   9. STI/STIPA measurements at each measurement point
   10. Final corrected STI/STIPA values where the post processing procedure is used
   11. Indication of whether or not the test met the pass/fail criteria
   12. Record of system restoration
   13. Any additional information to assist with future evaluation of system performance.

C. The as-built drawings shall be updated based on the results of the test.

6.03 Warranty and Maintenance
A. The contractor shall warranty all materials, installation and workmanship for three (3) years from date of acceptance by the University of Texas, unless otherwise specified. A copy of the manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.

B. Materials, installation or workmanship found to be defective during that period shall be replaced without cost to the University of Texas. This Contractor shall initiate repair of any warranty defects within 8 hours of notification of such defects and shall be repaired within 24 hours.

C. The warranty or any part of the warranty shall not be made void by any required operation or inspection of the system after acceptance during the warranty period. The University of Texas will use University of Texas personnel to provide required tests and inspections.

D. If the Owner experiences more than two Nuisance alarms or unexplained false alarms or troubles in any 24-hour period while the system is under warranty, the Contractor shall provide the necessary labor, materials, and technical expertise to promptly correct the problem(s) at no cost to the University of Texas.

E. The fire alarm contractor shall maintain a service organization with adequate spare parts stock within 75 miles of the installation.

F. Spare Parts - The Contractor shall supply the following spare parts:
   1. Automatic detection devices - Two (2) percent of the installed quantity of each type.
   2. Manual fire alarm stations - Two (2) percent of the installed quantity of each type.
   3. Modules - Two (2) percent of the installed quantity of each type.
   4. Audible and visible devices - One (1) percent of the installed quantity of each type and color, but no less than two (2) devices.
   5. Keys - A minimum of three (3) sets of keys shall be provided and appropriately identified.

6.04 Training

A. Provide services of manufacturer's representative to instruct Owner's personnel in operation and maintenance of system for a minimum of two 4 hour sessions.

B. Factory training at the expense of the Fire alarm contractor for two UT FSSS Personnel is required for the installed system. Expenses shall include all travel, hotel, meals, training and training materials.

END OF STANDARD
EMERGENCY COMMUNICATION SYSTEM (ECS) PANEL

1. Provide in-building Emergency Communication System (ECS) panel adjacent to or near fire alarm control panel (specify location of fire alarm panel in the building under design). Coordinate mounting location with architect and owner. Panel to be surface mounted at an accessible height.

2. ECS panel to be Federal Signal product containing the following: UVIC-IP Controller, UV Audio & Relay (ARM), and Digital Voice Mini SD card. Insure UV arm relays are continuously engaged during live and pre-recorded messages, which will make sure that the UVIC-IP controllers maintain priority over the fire alarm panels when activated.

Provide battery backup capacity as recommended by Federal Signal for a 7 day power supply.

3. Provide pre-recorded system test message. The pre-recorded message is to contain a 10 second delay prior to voice to accommodate fire alarm control panel processing time. The delay time may contain tone signals.

4. Provide Ethernet connection coordinated with UT-ITS project manager and separate circuit 120V AC power for ECS panel. Coordinate with Federal Signal to configure TCP/IP network as required to permit ECS communications.

5. Fire Alarm specification to include: Program fire alarm system to accept line level audio and contact closure (push-to-talk signal or "PTT") from ECS panel. Prioritize ECS signal above fire alarm signals, above the building manager microphone, and below the on-board fire alarm fire control panel microphone.

6. Activation of the ECS panel shall activate building strobes.

7. Retain Federal Signal to install ECS panel and connect/configure ECS panel and head-end at dispatch as required to bring building into the in-building communication network.

8. Ensure building fire alarm system and Ethernet connection are operational prior to ECS panel connection.

9. Connect 600 ohm balanced line level audio output and dry contact relay from ECS panel to the existing auxiliary audio input board on the fire alarm control panel. All wiring shall be in conduit and audio wiring is to be shielded twisted pair. Ethernet conduit is only required at wall penetrations and below eight feet AFF. The junction boxes and connection at FACP is to be labeled, “ECS”.

10. Coordinate ECS testing with UT FSSS after installation and contractor testing is completed. Report completed and tested system installation to UT Campus Safety and Security office.
12. Verify the requested equipment will perform the required functions with Federal Signal and Fire alarm panel manufacturer prior to proceeding. Submit RFI for issues and/or deviations.

SUPPLEMENTAL EMERGENCY MICROPHONE

1. Surface mount supplemental microphone in a public area near the fire alarm panel. If walls are fire resistance rated construction, maintain rating with installation.

2. Connect supplemental microphone to fire alarm control panel. All wiring shall be in conduit. Junction boxes and connection at FACP are to be labeled "Building Manager Microphone" with permanent labels.

3. Supplemental microphone enclosure panel height shall be 48 inches AFF to the top. Enclosure shall not protrude more than 4 inches into egress space.

4. Interface with FACP as required to connect the supplemental microphone. Installed microphone is to function as supplemental device only.

5. Activation of supplemental microphone shall not activate strobes as directed by the University.

6. Supplemental microphone shall be prioritized beneath fire alarm signals as directed by the University. Pre-recorded fire alarm messages and on-board fire alarm microphone shall override supplemental microphone if activated.

7. Coordinate construction times with University of Texas.

8. Coordinate enclosure mounting location and method with architect and owner.

9. Ensure feedback is not created by microphone use. Adjust adjacent speaker output if necessary - adjacent speaker can be removed if required.

10. Provide Hoffman model ATC10104S 10"x10"x4" (or sized as required to contain microphone) surface-mounted enclosure (or recessed at locations identified) to contain supplemental microphone locked with key part #87573327. Verify remote microphone fits within enclosure. For examples, reference supplemental microphone enclosure at UT MAI.

11. Provide fire alarm manufacturer’s Remote Microphone within enclosure. Provide additional equipment as required to connect to fire alarm control panel.

12. Provide 1" x 3" adhesive-backed phenolic labels with white letters on a black background reading, “Building Manager”, on the supplemental microphone enclosure.

13. Verify requested microphone and enclosure will perform the required functions prior to proceeding. Submit RFI for issues and/or deviations.
SECTION 32 01 90 – OPERATION AND MAINTENANCE OF PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Description

1. Work included: Provide labor, materials, and installation necessary to provide a one (1)-year warranty period for trees, shrubs, ground covers, and lawn areas from date of acceptance of installation. Provide labor, materials, and installation necessary to provide a (1)-year maintenance period from date of acceptance of substantial completion. Unless it is determined to reduce the maintenance period to 90 days, by UT Landscape Services.

2. Related Sections described elsewhere:
   a. Section 32 93 00 – Planting
   b. Section 32 92 00 – Turf and Grasses
   c. Section 32 XX XX – Trees

PART 2 - PRODUCTS

2.1 FERTILIZER

A. TBD, Fertilizer at the rate indicated, if recommended by soil test (Texas Soil and Plant Lab recommendations).

2.2 INSECTICIDE

A. Submit for approval by UT Landscape Services labels for all proposed insecticides to be used on-site, if needed. Specify what pests they will be used to control and application rates. Maintain accurate application/spray records and submit copies to UT Landscape Services.

2.3 HERBICIDE

A. Submit for approval by UT Landscape Services labels for proposed herbicide to be used on-site. Specify what weeds they will be used to control and application rates. Provide names and license of applicator. Maintain accurate application/spray records and submit copies to UT Landscape Services.

PART 3 - EXECUTION

3.1 ACCEPTANCE OF INSTALLATION

A. At the completion of all landscape installation, the Contractor shall request in writing an inspection for substantial completion in which the Contractor and Owner's Representative shall be present. After this inspection, the Contractor shall prepare a “Punch List”. Upon completion of all punch list items, the Owner's Representative shall re-inspect the project and issue a written statement of final acceptance and establish the beginning of the project warranty period.

B. Landscape work may be inspected for acceptance in a limited number of phases agreeable to UT Landscape Services provided work offered for inspection is completed, including maintenance as required.
C. For work to be inspected for partial or phased acceptance, the contractor shall provide a drawing outlining work completed and supply a written statement-requesting acceptance of the work completed to date.

3.2 PROJECT WARRANTY

A. The project warranty period shall begin upon written final acceptance of the landscape installation by the UT Representative.

B. Tree Warranty:

1. The Contractor shall warrant that all trees will be alive and in good health for a period of one (1) year after final acceptance except for defects resulting from neglect by the Owner, abuse, or damage by others.

2. If the contractor is not performing a one-year maintenance period, the Contractor shall be responsible to monitor UT Landscape Service’s care and report any maintenance issues before problems occur.

3. The Contractor shall remove and replace dead, unhealthy or girdled trees or those that lose original form and size during the warranty period with material equal to that specified at no additional cost to UT Austin. The Contractor shall replace any material that does not meet requirements within ten (10) days.

4. All replacement trees shall be subject to an additional one (1)-year warranty period.

C. Shrubs and Other Plantings Warranty:

1. The Contractor shall warrant all other planting to be alive and in satisfactory condition for a period of one (1) year from date of final acceptance except for defects resulting from neglect by the Owner, abuse, or damage by others.

2. The Contractor shall maintain all plant material in a healthy, sturdy condition during the warranty period.

3. The Contractor shall remove and replace dead or unhealthy shrubs, ground covers, vines and turf areas or those that lose original form and size during the warranty period with material equal to that specified at no additional cost to the Owner. The Contractor shall replace any material that does not meet requirements within ten (10) days.

4. All replacement plants, including shrubs, groundcovers, vines and perennials, shall be subject to an additional one (1)-year warranty period.

3.3 MAINTENANCE PERIOD

A. Maintenance shall begin immediately with the planting of each plant and continue (1)-year after substantial completion.

1. Contractor shall take every precaution to protect finished exterior surfaces from damage as result of his maintenance work and shall promptly report and repair any damage to the satisfaction of the Owner’s Representative.
B. Replacements must meet specifications, i.e., quality, size, form, species of plant material and planting procedures, to receive approval of replacement.

C. To ensure warranty standards, the following maintenance procedures shall be executed during construction and for the full project maintenance period.

D. Response Time: When environment dictates, work may require weekend, after hours or holiday schedules. The Contractor agrees to respond to a call per the following schedule:
   1. General Maintenance- Three (3) business days.
   2. Irrigation Issues- 24 hours or less depending on severity.
   3. Safety Issues (obstructions, etc.)- Immediately

E. Maintenance of Trees, Shrubs, Vines and Groundcovers:
   1. Contractor shall be responsible for any and all replacement of any plant materials that are dead, are in an unhealthy or unsightly condition, or that have lost natural shape resulting from dieback, excessive pruning or inadequate or improper maintenance.
   2. Replacements must meet specifications, i.e., quality, size, form, species of plant material and planting procedures, to receive approval of replacement.
   3. Costs for replacements are assumed part of bid quotations and therefore will not result in an additional cost to UT Austin.
   4. The Contractor shall be responsible for watering all plantings and shall keep guy wires taut, raise tree rootballs that settle, and furnish chemicals and pesticides as necessary to keep the plantings free of disease and insects until the end of the maintenance period.
   5. Chemical Application: Furnish and apply chemicals and pesticides if necessary to keep the plantings free of disease and insects throughout the maintenance period. Must be approved by UT Landscape Services prior to application.
   6. Fertilization: TBD, Fertilizer at the rate indicated, based on soil analysis recommendations from Texas Plant & Soil Lab (Texas Plant and Soils Lab, Edinburg, TX (936-383-0739)
   7. Weed Control: Project Area is to be maintained in a weed-free condition. All planting areas shall be kept clean bi-weekly of all noxious weeds and grasses.
   8. Remove and replace trees, shrubs, ground covers, vines, turf areas or other plants found to be dead or in an unhealthy condition. Remove rejected plants and materials promptly. Make replacements during the normal planting schedule. Replace all trees and shrubs where their health is in doubt, unless, in the opinion of UT Landscape Services, it is advisable to extend warranty period. Remove all tree wrap paper, dead twigs and branches from tree and plant material at the end of the maintenance period. Keep planting beds free of weeds during maintenance period.
   9. Pruning:
      a. Trees: The objective in tree pruning shall be to preserve the structural integrity, design purpose and natural beauty of trees. Branch collars shall not be removed. Stubs shall not be allowed to remain. All pruning shall be done in accordance with the guidelines of the Western Chapter of the International Society of Arboriculture, ANSI Standards.
b. Shrubs: Pruning shall be done with hand pruners or lopping shears. Shrubs shall be selectively pruned to remove old seed heads and stems, and pruned on a very limited basis, only to maintain natural appearance. Shrubs shall not be pruned into ball or geometric shapes. Shrubs and groundcovers shall be pruned to remove all frost-damaged foliage and branches as soon as new buds appear. Shrubs shall be trimmed to prevent overhang at sidewalks and curbs.

a. Staking and Planting (IF NECESSARY):

   a. Staking shall be inspected monthly. The goal is to wean trees from stakes. As trees are strong enough to stand on their own, stakes shall be removed.

   b. Stakes that are not judged to be ready for removal shall be maintained according to the detail. Rubber hose and wire encircling trunks shall be maintained so as not to cause girdling. Stakes and wire shall be maintained to prevent rubbing against trunks or branches. Materials for staking and/or restaking shall match original specification. The need for the stakes and guys to remain beyond the warranty period is to be determined at the end of the warranty period. Approval to remove the stakes and guys at that time will be determined by UT Landscape Services.

b. Maintenance of Turf Areas: Maintain turf per overall landscape maintenance and warranty specifications. Partial acceptance will not be considered. At end of maintenance period, turf shall have 100% coverage and be vigorously growing, healthy, uniform in color and capable of supporting daily use. Roots shall have minimum depth of 8-inches.

F. Maintenance Acceptance.

1. If the Contractor's maintenance is unsatisfactory, the maintenance period shall be extended, at the Contractor's expense, until such time as all corrections are made and the work is inspected and approved by the UT Representative.

2. Arrange with UT Representative to walk the site monthly during warranty period to review maintenance standards, and correct deficiencies/problems. Must be completed within 3 business days.

3. The Landscape Contractor shall notify UT Representative five (5)-days prior to end of the maintenance period that a final inspection is requested. UT Representative shall make notations of any items not acceptable or requiring corrections and will notify the Landscape Contractor for immediate action. All corrections must be completed before the Subcontractor is released from the above maintenance requirement.

END OF SECTION 32 01 90
PART 1 GENERAL

1.01 GENERAL CONDITIONS

The requirements of the University of Texas at Austin Uniform General Conditions and Supplementary General Conditions, 2013 Amended shall apply to all work of this section with the same force and effect as though repeated in full herein.

1.02 SCOPE OF WORK

Furnish all labor, materials, equipment, transportation, and services necessary to furnish and install the Irrigation System complete in place, as shown on the drawings and specified herein.

1.03 DEFINITIONS

A. Landscape Services Representative: University of Texas at Austin – Landscape Services Representative
B. Architect: Designer Representative
C. Contractor: General Contractor or any sub-contractor responsible for the work specified herein.
D. Final Acceptance of Installation: This acceptance will be granted upon completion of installation of the complete irrigation system according to the plans and as specified herein. Final Acceptance of Installation will not occur before the Final Inspection.
E. Final Inspection: The last inspection immediately prior to Final Acceptance of Installation.

1.04 STANDARDS

ASTM D1785 (ANSI B72.7): Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

1.05 QUALITY ASSURANCE AND REQUIREMENTS

A. Contractor's Qualifications: Demonstrated experience on projects of similar characteristics and size.
B. Licensed Irrigator: Installation of the irrigation system shall be under the direct supervision of a superintendent or foreman currently licensed as an Irrigator/Irrigation Installer by the State of Texas.
C. Permits and Inspections
   1. In all cases, where inspection of the irrigation system is required and/or where portions of the work are specified to be performed under the direction and/or
inspection of the Landscape Services Representative, the Contractor shall notify
the Landscape Services Representative at least 24 hours in advance of the time
when inspection and/or direction is required, or as specified under "Observation
Schedule".

2. Any necessary re-excavation or alterations to the system needed because of the
failure of the Contractor to have the required inspections shall be performed at
the Contractor's expense.

D. Ordinances and Regulations: All local, municipal and state laws, and rules and
regulations governing or relating to any portion of this work are hereby incorporated into
and made a part of these specifications, and their provisions shall be carried out by the
Contractor. Anything contained in these specifications shall not be construed to conflict
with any of the above rules and regulations or requirements of the same. However,
when these specifications and drawings call for or describe materials, workmanship, or
construction of a better quality, higher standard, or larger size than is required by the
above rules and regulations, the provisions of the specifications and drawings shall take
precedence.

E. Manufacturer's Directions: Manufacturer's directions and detailed drawings shall be
followed in all cases where the manufacturers of articles used in this contract furnish
directions covering points not shown in the drawings and specifications.

F. Explanation of Drawings:
1. Due to the scale of drawings, it is not possible to indicate all offsets, fittings, etc.
which may be required. The Contractor shall carefully investigate the structural
and finished conditions affecting all of their work and plan their work accordingly,
furnishing such fittings, etc. as may be required to meet such conditions.
Drawings are generally diagrammatic and indicative of the work to be installed.
The work shall be installed in such a manner as to avoid conflicts between
irrigation systems, planting, and architectural features.

2. All work called for on the drawings by notes or details shall be furnished and
installed whether or not specifically mentioned in the specifications.

3. The Contractor shall not willfully install the irrigation system as shown on the
drawings when it is obvious in the field that obstructions, grade differences or
discrepancies in area dimensions exist that might not have been considered.
Such obstructions or differences should be brought to the attention of the
Landscape Services Representative. In the event this notification is not
performed, the Contractor shall assume full responsibility for any revision
necessary.

G. Damage to Existing Site Amenities
Damage to existing irrigation and electrical lines to remain shall be repaired within 24
hours of damage occurrence. If not repaired within the specified time, the Landscape
Services Representative has the right to make such repairs as necessary and all costs
incurred shall be charged to the Contractor.

1.06 CONTRACTOR'S RESPONSIBILITY
A. Prior to submittal of bids, Contractor shall acquaint himself with all matters and
conditions concerning the site and existing conditions.

B. Contractor shall be responsible for coordinating his work with the other trades so that all
phases of the work may be properly coordinated without delays or damage to any parts
of the work.

C. The Contractor shall be responsible for all sleeves and chases under paving, through
walls, etc., unless otherwise noted on the plans.
1. Any pipe installed under a sidewalk, driveway, or concrete area should be in a sleeve.
2. Sleeve should be twice the size of the pipe going through it.
3. An extra 2” sleeve shall be installed under any sidewalk, driveway, or concrete area.

1.07 SUBMITTALS

A. Material List:
   1. The Contractor shall furnish the articles, equipment, materials, or processes specified by name in the drawings and specifications. No substitution will be allowed without prior written approval by the Landscape Services Representative.
   2. Complete material list shall be submitted prior to performing any work if different from the plans. Material list shall include the manufacturer, model number and description of all materials and equipment to be used.
   3. Equipment or materials installed or furnished without prior approval of the Landscape Services Representative may be rejected and the Contractor required removing such materials from the site at his own expense.
   4. Approval of any item, alternate or substitute indicates only that the product or products apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted.
   5. Manufacturer's warranties shall not relieve the Contractor of their liability under the guarantee. Such warranties shall only supplement the guarantee.

B. Record and As-Built Drawings:
   1. The Contractor shall provide, and keep up to date, a complete “as-built” set of black or blue line prints which shall be corrected daily and show every change from the original drawings and specifications and the exact “as-built” locations, sizes, and kinds of equipment. Prints for this purpose may be obtained from the Landscape Services Representative. This set of drawings shall be kept on the site and shall be used only as a working set.
   2. These drawings shall also serve as work progress sheets and shall be the basis for measurement and payment for work completed. These drawings shall be available at all times for inspection and shall be kept in a location designated by the Landscape Services Representative. Should these “as-built” progress sheets not be available for review or not be up-to-date at the time of any inspection, it will be assumed that no work is completed.
   3. The Contractor shall make neat and legible notations on the "as-built" progress sheets daily as the work proceeds, showing the work as actually installed. For example, should a piece of equipment be installed in a location that does not match the plan, the Contractor must indicate that equipment has been relocated in a graphic manner so as to match the original symbols as indicated in the irrigation legend. The relocated equipment and dimensions will then be transferred to the original Record plan at the proper time.
   4. After final inspection, but before final acceptance, the Contractor shall submit to the Landscape Services Representative the "as-built" prints. These prints shall be submitted before final payment will be made.
   5. The Contractor shall dimension from two (2) permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following items:
a. Connections to water lines.
b. Connection to electrical power.
c. Gate valves.
d. Routing or sprinkler pressure lines (Mainline and Lateral lines)
e. Sprinkler control valves.
f. Routing of control wiring.
g. Quick coupling valves.
h. Other related equipment as directed by the Landscape Services Representative.

6. GIS Requirements for University Operations
   1. GIS data: Horizontal and vertical geometry and attribute data shall be loaded into or created in the LISwaterDistribution-4-12-16.mdb. At a minimum, record the following attributes for pipes and appurtenances:
      a. Type
      b. Diameter
      c. Material
      d. Manufacturer

   2. For system components that have nameplates, document all information on the nameplate. This usually includes the following information:
      a. Manufacturer
      b. Model number
      c. Size
      d. Component material or model numbers (e.g., stem, disc, seat, class)
      e. Pressure rating
      f. In-service date

   3. All new and existing active underground and underslab utilities and appurtenances exposed during construction shall be recorded. Coordinates with applicable field notes shall be recorded at:
      a. Any significant change in direction, material, or size
      b. Deviations from design greater than 6 inches in any direction
      c. All appurtenances (valves, junctions, etc.)
      d. Every 50 feet otherwise

   4. The final deliverable coordinate system shall be:
      a. 2011 State Plane Texas Central FIPS 4203
      b. NAD83 (horizontal)
      c. NAVD88 (vertical)
      d. US Survey Feet
      e. Elevation above sea level

C. Operation and Maintenance Manuals:
   1. Prepare and deliver to the Landscape Services Representative within ten calendar days prior to final inspection, one digital copy:
      a. Index sheet stating Contractor’s address and telephone number, list of equipment with name and address of local manufacturer's representative.
b. Catalog and parts sheets on every material and equipment installed under this contract.

c. Complete operating and maintenance instructions on all major equipment.

2. In addition to the above mentioned maintenance manuals, provide the Landscape Services Representative with instructions for major equipment.

E. Equipment to be furnished to the Landscape Services Representative:

1. Supply as a part of this contract the following:
   a. Two (2) sets of special tools required for removing, disassembling and adjusting each type of irrigation head and valve supplied on this project, including solenoid wrenches.
   b. Two (2) keys for each automatic controller.
   c. Two (2) quick coupler keys with ells.

2. The above mentioned equipment shall be turned over to the Landscape Services Representative at the conclusion of the project before final inspection can occur.

1.08 DELIVERY, HANDLING, AND STORAGE

A. Delivery and Handling

1. Contractor is cautioned to exercise care in handling, loading, unloading, and storing of PVC pipe and fittings.

2. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point.

3. Any section of pipe that has been dented or damaged will be discarded and, if installed, shall be replaced with new piping at the expense of the Contractor.

B. Storage

1. If a storage site is necessary, the Landscape Services Representative will determine the storage site at the Pre-Construction Meeting after the award of the contract.

2. Contractor shall erect a temporary fence and store material inside of the fenced area.

3. Contractor shall be fully responsible for the management of the storage site.

4. Storage at the irrigation site shall not be permitted without written consent of the Landscape Services Representative.

5. All PVC pipe shall be covered or otherwise protected from ultraviolet light during storage.

6. Contractor shall maintain the storage area in a neat and orderly manner. If, in the opinion of the Landscape Services Representative, the storage area becomes unsightly, the Contractor shall clean up the storage area within two (2) days of notification.

7. At the completion of the contract, the Contractor shall remove the temporary storage fence and all debris in the area. The Contractor shall restore the storage area to original condition including, but not limited to, grading and turf re-establishment.

1.09 PUBLIC CONVENIENCE AND SAFETY
A. Materials stored about the work shall be so placed and work shall at all times be so conducted as to cause no greater obstruction to the travelling public than is considered necessary by the Landscape Services Representative.

B. The materials excavated, and the construction materials used in the construction of the work, shall be placed so as not to endanger the work or prevent free access to all fire hydrants, water valves, gas valves, manholes for the telephone, telegraph signal or electric conduits, sprinkler systems, sanitary sewers, and fire alarm or police call boxes in the vicinity.

C. The Landscape Services Representative reserves the right to remedy any neglect on the part of the Contractor as regards the public convenience and safety which may come to its attention, after twenty-four hours notice in writing to the Contractor, save in cases of emergency, when it shall have the right to remedy any neglect without notice and, in either case, the cost of such work done by the Landscape Services Representative shall be deducted from the monies due the Contractor.

D. This project is located on property which could be used by the Public during the course of this agreement. For this reason, the Contractor must observe the utmost care in regards to the Public's safety. Any possible hazards which could result in injury must be eliminated as soon as possible.

E. No trenches, ditches, etc. shall remain open overnight outside protective fencing without approval from the Landscape Services Representative.

F. Any ditches which are left open must be covered securely so as to prevent any possibility of injury. It shall be the Contractor's responsibility to eliminate any hazards during and after working hours and the Contractor must have personnel available who can eliminate hazards which are discovered after normal working hours and on the weekends and holidays.

G. Contractor assumes all responsibility for open trenches, ditches etc.

1.10 SUBSTITUTIONS

A. If the Contractor wishes to substitute any equipment or materials for the equipment or materials listed on the irrigation drawings and specifications, they may do so by providing the following information to the Irrigation Supervisor for approval:

1. Substitution requests will be considered only after award of the contract.
2. Substitution requests must be made within 30 days after award of the contract.
3. Provide a statement indicating the reason for making the substitution. Use a separate sheet of paper for each item to be substituted.
4. Provide descriptive catalog literature, performance charts, and flow charts for each item to be substituted.
5. Provide the amount of cost savings if the substituted item is approved.

B. The Landscape Services Representative shall have the sole responsibility in accepting or rejecting any substituted item as an approved equal to those equipment and materials listed on the irrigation drawings and specifications.

C. Decisions on substitutions by the Irrigation Supervisor are final.

1.11 CHANGES IN THE WORK

A. The Landscape Services Representative may, without invalidating the contract, order additional work or alterations to the contract.

B. Minor changes, such as head locations and controller location, which do not involve extra cost and are consistent with the purpose of the work, may be ordered by the Landscape Services Representative and no claim for an addition to the contract sum or time schedule will be considered.
C. Any changes which affect the contract price shall be requested in writing and the contract sum shall be adjusted. Any extension of time due to additions in work shall be adjusted at the time of the change order.

1.12 FINAL INSPECTION
A. A qualified person duly authorized in writing to represent the Contractor shall be present at the final inspection to demonstrate the system and prove the performance of the equipment.
B. Prior to the final inspection, all work under this division shall have been completed, tested, balanced and adjusted and in final operation condition.
C. Irrigation Supervisor or Landscape Services Representative will be present during inspection and must sign off on all irrigation work.

1.13 GUARANTEE
A. Materials and workmanship shall be fully guaranteed for one year after final acceptance. All material will be new and the current production model of the material specified.
B. Guarantee is limited to repair and replacement of defective materials or workmanship, including repair of backfill settlement.
C. The Contractor, at his expense, shall repair any defects or replace any defective parts found or occurring during the one year guarantee period within 48 hours of notification by the.

PART 2--PRODUCTS

2.01 MATERIALS
A. General: All materials and accessories shall be of new and unused material. Any section of pipe found to be defective before or after installation shall be replaced with new pipe at the expense of the Contractor. All new irrigation equipment shall be essentially the standard product of the manufacturer. All new equipment furnished shall have in-service performance records sufficient to verify published capabilities.
B. PVC Pressure Main Line Pipe and Fittings
1. Pressure main line piping shall be PVC Schedule 40, solvent weld joints, purple color.
2. Pipe shall be made from an NSF approved Type I, Grade II, PVC compound conforming to ASTM resin specification D1785. All pipes must meet requirements as set forth in Federal Specification PS-22-70, with an appropriate standard dimension ratio (SDR) (Solvent-weld pipe).
3. PVC solvent-weld fittings shall be Schedule 40, 1-2, II-I NSF approved conforming to ASTM test procedure D2466.
4. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation methods prescribed by the manufacturer. Primer must be purple IPS Weldon P-68 or approved equal.
5. All PVC pipe must bear the following markings:
   a. Manufacturer’s name
   b. Nominal pipe size
   c. Schedule or class
   d. Pressure rating in P.S.I.
   e. NSF (National Sanitation Foundation) approval
f. Date of extrusion

6. All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable I.P.S schedule, and NSF seal of approval.

C. PVC Non-Pressure Lateral Line Piping:
1. Non-pressure lateral line piping shall be PVC Schedule 40, solvent-weld joints, purple color. No class 200 pipe to be installed.
2. Pipe shall be made from NSF approved, Type I, Grade II PVC compound conforming to ASTM resin specification D1785. All pipes must meet requirements set forth in Federal Specification PS-22-70 with an appropriate standard dimension ratio.
3. Except as noted in paragraphs 1 and 2 of section 2.01B, all requirements for non-pressure lateral line pipe and fittings shall be the same as for solvent-weld pressure main line pipe and fittings as set forth in section 2.01B of these specifications.
4. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation methods prescribed by the manufacturer. Primer must be purple IPS Weldon P-68 or approved equal.

D. Ball Valves:
1. Install one ball valve prior to each electric valve location for isolation purposes. Ball Valves shall be of size and type as indicated on the irrigation drawings.

E. Quick coupling Valves:
1. Quick coupling valves shall have a brass two-piece body designed for working pressure of 150 P.S.I. with a .75 inch diameter outlet. Key size and type shall match the valve. Rainbird 33DRC with 33DK valve key or approved equal and with purple top.

F. Backflow Prevention Units:
1. Backflow prevention units shall be of size and type indicated on the irrigation drawings. Install backflow prevention units in accordance with irrigation construction details.

G. Control Wiring:
1. Connections between the automatic controllers and the electric control valves shall be made with direct burial copper wire AWG-U.F. 30 volt. Pilot wires shall be a different color wire for each automatic controller. Common wires shall be white with a different color stripe for each automatic controller. Install in accordance with valve manufacturer's specifications and wire chart. In no case shall wire size be less than #14. All electrical work shall conform to code.
2. Lay one additional control wire from each controller to the farthest valve in each direction from the controller. This wire control is to be a different color from the other control and common wire.
3. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible. All wire shall be placed under all pipes in the trench.
4. Where more than one (1) wire is placed in a trench, the wiring shall be taped together at intervals of ten (10) feet.
5. An expansion curl/coil shall be provided within three (3) feet of each wire connection. Curl must be 10 to 15 wraps around a .75 inch pipe. Expansion curl shall be of sufficient length at each splice connection at each electric control, so that in case of repair, the valve bonnet may be brought to the surface without disconnecting the control wire. Control wires shall be laid loosely in trench without stress or stretching of control wire conductors.
6. An expansion curl shall be provided every 125-150 feet along all wire runs.
7. All splices shall be made with Scotch-Lok #3576 Connector Sealing Packs, Rainbird Snap-Tite wire connector, or approved equal. Use one splice per connector sealing pack.
8. Limit wire splices between the automatic controller and electrical control valves, locate ALL WIRE SPLICES on "as built" drawings. Wire splice shall be installed in a separate box (minimal 10" box)
9. 2 extra wires (BLUE COLOR) from the controller to be run to the farthest irrigation zones.

H. Automatic Controllers:
1. Automatic controllers shall be of size and type shown on the plans. Ground the controller according to manufacturer's directions.
2. Final location of automatic controllers shall be approved by the Landscape Services Representative.
3. Install controller pedestal per the manufacturer's instructions.
4. Irrigation controller shall be a Calsense ET2000e LR, RRe, -F, with TP board, and radio frequency of 452.6875.

I. Electrical Control Valves:
1. All electric control valves shall be as called for on the plans.
2. All electric control valves shall have a manual flow adjustment.
3. Provide and install one control valve box for each electric control valve.
4. A master valve shall be installed on all water sources.
5. All electric control valves shall be labeled with zone identification tags.
6. All electric control valves shall be installed in a manifold in a machine/valve room and large enough to accommodate backflow prevention valves, and controller. This room must have a floor drain, and an exterior entrance for 24-Hour access. In the event that a machine/valve room is not a possibility a concrete vault may be substituted as a last resort.
7. All valves shall be labeled to their corresponding valve number in the field.
8. Valve installed inside buildings shall be brass.
9. Weathermatic, Rainbird, and Hunter valves shall be installed.

J. Control Valve Boxes:
1. Use a 10 inch round box with purple locking cover for all gate valves, NDS, or approved equal. Extension sleeve shall be used where needed.
2. Use 12 X 17 valve boxes for valves up to 1 ½"; 17 X 30 for valves 2" and greater with purple locking cover for all electrical control valves, NDS or approved equal.

K. Irrigation Heads/Nozzles:
1. All irrigation nozzles shall be of the same size, type, and deliver the same rate of precipitation with the diameter (or radius) of throw and discharge as shown on the plans and/or as specified herein. All irrigation heads shall use HUNTER MP Rotary nozzles
2. Spray nozzles shall have a screw adjustment.
3. Riser units shall be fabricated in accordance with the details shown on the plans.
4. Riser nipples for all irrigation heads shall be the same size as the riser opening in the body of the head.
5. All irrigation heads of the same type shall be of the same manufacturer; pop-up spray heads: 1806 SAM PRS Rainbird (1812 SAM PRS in landscape beds), large turf heads/rotors: PGP Hunter series; athletic field turf heads/rotors: Hunter I series (25, 40, 60, 90) or approved equal.
6. All irrigation heads shall be installed on a swing joint.

L. Flow Sensor:
1. Flow sensor shall be Calsense Flow meter.
2. Size of flow meter will be based off highest and lowest zone flow (NOT BASED OFF MAINLINE SIZE)

M. Drip Irrigation:
1. Drip irrigation shall be installed 4 inches below soil. No installation of drip pipe shall be directly under mulch.
2. Drip emitter spacing shall be 12” at .9 GPH.
3. All drip irrigation valves shall have a filter and pressure reducer on them.

N. Copper Piping:
1. Any irrigation piping inside of a building must be Copper pipe and affixed with a water proof label with block lettering labeled “IRRIGATION”, per plumbing code.

O. Moisture Sensors:
1. Minimal of four Toro TG-S2-R Dual Level Sensor shall be installed on the site.
2. Minimal of one Toro repeater (Turf Guard) shall be installed on the site.

PART 3--EXECUTION
3.01 INSPECTION
A. Site Conditions:
1. All scaled dimensions are approximate. The Contractor shall check and verify all size dimensions and receive Landscape Services Representative's approval prior to proceeding with work under this section.
2. Exercise extreme care in excavating and working near existing utilities. Contractor shall call Texas 811 prior to any digging and contacting UT Utilities. Contractor shall be responsible for damages to utilities which are caused by their operations or neglect. Verify existing utilities with the appropriate utility Landscape Services Representative i.e.: electricity, gas, cable, telephone.
3. Damaged utilities shall be repaired by the Contractor the same day they are damaged.
4. Coordinate installation of irrigation materials including pipe, so there shall be NO interference with utilities or other construction or difficulty in planting trees, shrubs, and ground covers.
5. The Contractor shall carefully check all grades to satisfy themselves that they may safely proceed before starting work on the irrigation system.

3.02 PREPARATION
A. Physical Layout:
1. Prior to installation, the Contractor shall stake out all pressure supply lines and valve locations.
2. All layouts shall be approved by the Landscape Services Representative prior to installation.

B. Water Supply:
1. Landscape Irrigation system shall be connected to water supply points of connection as indicated on the drawings.
2. Contractor shall verify static water pressure prior to commencement of construction/installation. Should there be a discrepancy between the design pressure and the actual pressure, contact the Landscape Architect before proceeding with the work. Failure to do so will result in the Contractor making
necessary changes to the irrigation system without additional cost to the Landscape Services Representative.

3. The Contractor shall provide all required water taps and water meters necessary for the project as indicated on the plans.

4. Connections shall be made at approximated locations as shown on drawings. Contractor is responsible for minor changes caused by actual site conditions.

C. Electrical Supply:
1. Electrical service must be provided to the controllers by the Contractor. The Contractor shall make the final wiring of the controller. Electrical work shall conform to applicable codes.
2. Connections shall be made at approximate locations as shown on drawings. Contractor is responsible for minor changes caused by actual site conditions.

3.03 INSTALLATION

A. Trenching:
1. Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow layout indicated on drawings and as noted.
2. Provide for a minimum of eighteen (18) inches cover for all pressure supply lines.
3. Provide for a minimum cover of twelve (12) inches for all non-pressure lines.
4. Provide for a minimum cover of eighteen (18) inches for all control wiring.
5. Install pipe so that writing on pipe can been seen during inspection.
6. NO MACHINE TRENCHING IN THE CRITICAL ROOT ZONE. (This note must be included on plans in English and Spanish)

B. Backfilling:
1. The trenches shall not be backfilled until all required tests are preformed and inspections are made by UT – Austin Landscape Services staff. Partial backfilling between joints is acceptable to prevent pipe from floating. Trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted in landscaped areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill will conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.
2. Flooding of trenches is an acceptable means of settling soil in the trench.
3. If settlement occurs and subsequent adjustments in pipe, valves, sprinkler heads, lawn or planting, or other construction are necessary, the Contractor shall make all required adjustments without cost to the Landscape Services Representative.

C. Trenching and Backfill Under Paving:
1. All piping and wiring under existing and proposed paving shall be in appropriate sized sleeves. REFERENCE 1.06.C
2. Trenches with pipe and wire to be located under areas where paving, asphaltic concrete or concrete will be installed shall be backfilled with sand (a layer three (3) inches below the pipe and six (6) inches above the pipe) and compacted in layers to 95% compaction, using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and shall be left in a firm unyielding condition. All trenches shall be left flush with the adjoining grade. The Contractor shall set in-place, cap, and pressure test all piping under paving.
3. Generally, piping under existing walks is done by jacking or boring, but where any cutting or breaking of sidewalks and/or concrete is necessary, it shall be done and replaced by the Contractor as a part of the contract cost. Permission to cut or break sidewalks and/or concrete shall be obtained from the Landscape Services Representative.

4. Provide for a minimum cover of eighteen (18) inches between the top of the pipe and the top of pavement for all pressure and non-pressure piping installed under any paving.

5. **NO MACHINE TRENCHING IN THE CRITICAL ROOT ZONE.** *(This note must be included on plans in English and Spanish)*

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D. **Assemblies:**

1. Routing of irrigation lines as indicated on the drawings is diagrammatic. Install lines (and various assemblies) in such a manner as to conform with the details and plans.

2. Install NO multiple assemblies in plastic lines. Provide each assembly with its own outlet.

3. Install all assemblies specified herein in accordance with respective detail. In absence of detail drawings or specifications pertaining to specific items required to complete work, perform such work in accordance with best standard practice with prior approval of Landscape Services Representative.

4. PVC pipe and fittings shall be thoroughly cleaned of dirt, dust, and moisture before installation. Installation and solvent welding methods shall be as recommended by the pipe and fitting manufacturer.

5. On PVC to metal connections, the Contractor shall work the metal connections first. Teflon paste shall be used on all threaded PVC to PVC, and on all threaded PVC to metal joints. Light wrench pressure is all that is required. Where threaded PVC connections are required, use threaded PVC adapters into which the pipe may be welded.

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E. **Automatic Controller:** Install as per manufacturer's instructions. Remote control valves shall be connected to controller in numerical sequence as shown on the drawings.

F. **120 Volt wiring for Automatic Controller:** Wire controllers per appropriate code. Install liquid tight conduit when wire must be run above the ground.

G. **Remote Control Valves:** All electric control valves shall be installed in a manifold in a machine/valve room and large enough to accommodate backflow prevention valves, and controller. This room must have a floor drain, and an exterior entrance for 24-Hour access. In the event that a machine/valve room is not a possibility a concrete vault may be substituted as a last resort.

1. Acquire approval from Landscape Services Representative for all valve locations when inside installation is not possible. When grouped together, allow at least twenty-four (24) inches between valve boxes. Install each remote control valve in a separate valve box.

   1. Minimal 6” clearance between valve and pea gravel.

H. **Flushing of System:**

1. After all new irrigation pipe lines and risers are in place and connected, all necessary diversion work has been completed, and prior to installation of irrigation heads, the control valves shall be opened and full head of water used to flush out the system.
2. Irrigation heads shall be installed only after flushing of the system has been accomplished to the complete satisfaction of the Landscape Services Representative.

I. Irrigation Heads:
1. Install the irrigation heads as designated on the drawings.
2. Spacing of heads shall not exceed the maximum indicated on the drawings and shall achieve head to head coverage. In no case shall the spacing exceed the maximum recommended by the manufacturer.

3.04 TEMPORARY REPAIRS
A. The Landscape Services Representative reserves the right to have made temporary repairs as necessary to keep the irrigation system equipment in operating condition. The exercise of this right by the Landscape Services Representative shall not relieve the Contractor of their responsibilities under the terms of the guarantee as specified herein. Costs incurred from these repairs shall be charged to the Contractor, or withheld from monies due to the Contractor.

3.05 FIELD QUALITY CONTROL
A. Adjustment of the System:
1. The Contractor shall flush and adjust all irrigation heads for optimum performance and to prevent over-spray onto walks, roadways, and buildings.
2. If it is determined those adjustments in the irrigation equipment will provide proper and more adequate coverage, the Contractor shall make such adjustments. Adjustments may also include changes in nozzle sizes and degrees of arc as required. Any and all changes shall be recorded on the Record Drawings.
3. All irrigation heads shall be set perpendicular to finished grades unless otherwise designated on the plans.

B. Testing of Irrigation System:
1. The Contractor shall request the presence of the Landscape Services Representative in writing at least 48 hours in advance of testing for inspection and witness of test.
2. Test all pressure lines under hydrostatic pressure at operating pressure, and prove watertight.
   Note: Testing of pressure mainlines shall occur after installation of electric control valves.
3. All piping under paved areas shall be tested under hydrostatic pressure at operating pressure and proved watertight.
4. Sustain pressure in lines for not less than two (2) hours. If leaks develop, replace joints and repeat test until entire system is proven watertight.
5. All hydrostatic tests shall be made in the presence of the Landscape Services Representative. No pipe shall be backfilled until it has been inspected, tested, and approved in writing. It is permissible to backfill between pipe joints to prevent pipe float. Leave all joints and connections exposed for inspection.
6. When the irrigation system is completed, perform a coverage test in the presence of the Landscape Services Representative, to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all
work required to correct any inadequacies of coverage due to deviations from plans, or where the system has been willfully installed as indicated on the drawings when it is obviously inadequate, without bringing this to the attention of the Landscape Services Representative. This test shall be accomplished before any planting takes place.

7. Upon completion of each phase of work, the entire system shall be tested and adjusted to meet site requirements.

8. An irrigation audit shall be completed on the irrigation zones for DU (Distribution Uniformity) with all zones having at least 65% DU. The audit should be done by a certified Irrigation Auditor and a formal report shall be delivered to Landscape Services at final inspection.

3.06 MAINTENANCE
A. 90 Day maintenance on the irrigation system.
B. The Landscape Services Representative reserves the right to waive or shorten the maintenance period.

3.07 CLEAN-UP
A. Clean-up shall be made as each portion of work progresses. Refuse and excess dirt shall be removed from the site and disposed of at the Contractors expense.
B. At the end of each work day, the Contractor shall leave the site area broom-clean and shall wash down all paved areas within the contract area, leaving the premises in clean condition. All sidewalks, paths, curbs and roads shall be left in a clean, safe condition.
C. All scars, ruts or other marks in the ground or surrounding area caused by this work shall be repaired to the original condition.

3.08 FINAL INSPECTION PRIOR TO FINAL ACCEPTANCE
A. The Contractor shall operate each system in its entirety for the Landscape Services Representative at time of final inspection. Any items deemed not acceptable by the Landscape Services Representative shall be reworked to the complete satisfaction of the Landscape Services Representative.

3.09 OBSERVATION SCHEDULE
A. Contractor shall be responsible for notifying the Landscape Services Representative in advance for the following observation meetings, according to the time indicated:
   1. Pressure supply line installation and testing--48 hours
   2. Automatic controller installation--48 hours
   3. Control wire installation--48 hours
   4. Lateral line and head installation--48 hours
   5. Coverage test--48 hours
   6. Final inspection--7 days

END OF SECTION
SECTION 32 90 00 – PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Description

1. Work included: Provide all labor, materials and installation necessary to complete the fine grading, incidental grading, planting and related work as required.

B. This Section includes the following:

1. Plant materials
2. Planting accessories
3. Planting mulch
4. Soils & soil amendments
5. Fertilizers, herbicides, and pesticides

C. Related work described elsewhere:

a. Section 32 84 00 – “Irrigation”
b. Section 32 01 90 – “Operation and Maintenance of Planting”
c. Section xx xx xx – “Trees”

1.2 REFERENCED STANDARDS

B. Standard Methods of the Association of Official Agricultural Chemists.
C. ASTM D 698 – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
E. United States Department of Agriculture (USDA) - Soils Classification Taxonomy.
G. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/urban/?cid=nrcs142p2_053993

1.3 LAWS, CODES AND REGULATIONS

A. Perform Work in accordance with all applicable laws, codes and regulations required by authorities having jurisdiction over such Work and provide for all inspections and permits required by federal, state and local authorities in furnishing, transporting and installing materials as shown or for completing the Work identified herein.

1.4 EXISTING UTILITIES

A. Existing utilities and improvements not designated for removal shall be protected in place. Any damage shall be repaired by the Contractor at no additional cost to UT Austin.

1.5 SUBMITTALS

A. Documentation for Sustainable Sites: For products that are extracted, harvested or recovered and manufactured from within 250 miles of Austin. Indicate location and distance from Austin of material manufacturer and point of extraction, harvest, or
recovery for each raw or recycled material. Include statement indicating costs for each product that is regionally extracted, harvested or recovered and manufactured.

B. General: Comply with Section 01 61 00 – Common Product Requirements.

C. Test Reports:

1. The Contractor shall submit landscape material test reports for the following:
   a. Existing topsoil source with nutrient analysis (Texas Plant and Soils Lab, Edinburg, TX (936-383-0739)
   b. Fertilizers/soil amendments/chemicals

2. A certified laboratory retained by the Contractor shall provide agronomy testing and verification of representative landscape material samples proposed for use on UT Austin projects. Testing includes, but is not limited to, the following:
   a. Plasticity index (PI)
   b. Soil pH
   c. Particle size, percentage soil texture
   d. Percentage organic material
   e. Nutrient level analysis
      - All macro, secondary and micronutrient
      - Nitrate
      - Potassium
      - Phosphorous
      - Calcium
      - Magnesium
      - Sodium
      - Percolation rate
      - Conductivity

3. Based on the above testing, the laboratory shall make recommendations on type and quantity of organic amendments required to bring these materials into acceptable ranges as specified in Part 2 – Products of this section. Contractor shall submit test results prior to, or at the same time as, the suggested amendments.

4. The Contractor shall submit separate agronomy tests with soil preparation recommendations for irrigated tree and shrub areas. A minimum of three (3) soil samples shall be tested. These samples are to be taken from various areas of the site with the objective of identifying differing soil conditions. Submit soil sample locations for approval prior to gathering sample. The location of each sample is to be identified on a map and a written summary. Each individual sample is to be prepared and presented to the UT Landscape Services. In addition to the analysis of the soil conditions the testing lab is to identify specific recommendations for supplementing and improving the soil to provide an optimal germination and growing condition.

5. Soil tests have already been completed for existing on-site fill material. Test results for his material, attached to this specification section as Exhibit 1, can be used by Contractor to determine amendments required to bring soil into acceptable ranges specified in Part 2 – Products of this section. All other soil to be used on site for landscape shall be tested as indicated above.

PART 2 - PRODUCTS
2.1 GENERAL

A. All plants and raw materials shall be manufactured and/or extracted or harvested within 250 miles of UT Austin site and all recycled or salvaged materials shall be manufactured and recovered within 250 miles.

B. Steel Edging

1. All planter beds which contact turf areas shall be edged between bed and turf, whether or not indicated on the plans, with specified steel edging. Set edging 2” above the turf finish grade. Top of mulch in planter beds will be level with top of steel edging.

2. Steel edge shall be ¼” x 6”, dark green or brown, commercial grade; install per manufacturer’s instructions.

2.2 PLANT MATERIAL

A. Plants shall be high quality, exhibit a growth habit that is normal for the species, and be sound, vigorous, healthy, and free from insects, plant diseases and injury. Container, box, ball, height and spread dimensions shall be measured according to specified standards and good practice.

B. Container plants shall have been in containers for sufficient length of time for root system to hold earth when taken from container but not long enough to become root-bound or cause “hardening-off.” Heeled-in stock or stock from cold storage is not acceptable. Plants cut back from larger sizes to meet specifications will not be acceptable.

C. Plant names shall conform to those given in "Standardized Plant Names" latest edition, prepared by the American Committee on Horticultural Nomenclature, or be names generally accepted by the trade.

D. Select, dig, transport, protect and plant in accordance with requirements of these specifications and "American Standards for Nursery Stock" and with accepted good practice.

E. Certificates shall accompany shipments as proof of inspection and quality as may be required by federal, state or other authorities. Each shipment shall be declared free of disease and insects of any kind. Label each plant or bundle and deliver bulk material in sealed, labeled bags, testifying as to percent of purity of contents.

F. Should any conflict arise as to the quality of any plant materials, the decision of UT Landscape Services is final.

G. Balled and Burlapped Stock: This stock will be defined as nursery plant stock which has been removed from the growing site with a ball of soil, containing the intact root system, and encased in burlap (or other approved similar material) to hold the soil in place. Ball sizes for balled and burlapped stock shall be as shown on the Drawings. NOTE: Remove entire wire basket, and half –two-thirds of burlap from rootball following installation.
H. Collected Stock: This stock will be defined as nursery plant stock, which has been removed from its original native habitat. All collected stock shall receive specific approval of the UT Landscape Services or designated representative before it can be removed from its existing habitat. Ball sizes for collected stock shall be as shown on the Drawings and shall have sufficient diameter and depth to encompass enough fibrous and feeding root system consistent with approved salvage methods and as necessary for the full recovery of the plant. Collection may be by hand or mechanical method.

I. Bag Grown Stock: This stock will be defined as nursery plant stock which has been transplanted into a nonwoven fabric container which has been placed in the ground and the plant grown under nursery field conditions continuously long enough - normally one (1) month for each inch of bag diameter i.e., a plant with a 24 inch diameter bag, grown in its original planted location for 24 months] for the fibrous roots to have developed so that the root mass retains its shape and holds together after removal of the bag. The root ball shall be flat bottomed and straight sided. Ball sizes for bag grown stock shall be as shown on the Drawings. Bag grown stock shall not be pruned before delivery.

J. Plant Size:

1. Trees 15 gallon and larger shall conform to the standards of Container Size to Caliper Height and Spread established and published by the American Standard for Nursery Stock Recommended Average Tree Specifications.

2. Plants will be measured when branches are in their normal position. Height and spread dimensions shown on the Drawings refer to the main body of the plant and not branch tip to tip. Plants with a spreading or semi-spreading habit will be measured by the average diameter of the spread. Plant heights will be measured by the mean height from the ground line to the top of the canopy. Caliper measurements will be taken at a point on the trunk six (6) inches above natural ground for trees up to four (4) inches in caliper and at a point twelve (12) inches above natural ground for trees over four (4) inches in caliper. The caliper size for multi-trunked plants will be determined by adding the calipers of the largest cane and one-half (1/2) the caliper(s) of the second and third largest cane(s).

3. When a range of size is shown on the Drawings, no plant shall be less than the minimum size and at least 40% of the plants shall be as large as the maximum size shown on the Drawings. The required measurements are the minimum sizes acceptable and are the measurements after pruning, when pruning is required.

4. Sizes of plants or plant types such as vines, groundcovers, seedings, young plants, understock, etc., will be measured in accordance with the plant standards or as indicated on the Drawings.

5. Container-grown plants which are well established in adequate size containers and are of equal quality and size to the specified balled plants may be accepted in lieu of balled plants; likewise, balled plants of equal quality and size may be substituted for container-grown plants when permitted by the Landscape Architect or designated UT Landscape Services. Soil shall be approximately 3/4 depth of container and contain roots of the plant throughout the soil.

6. The ball size for a balled and burlapped plant shall be firm natural balls equal to or in excess of the ball sizes indicated on the Drawings. Collected plant material substituted for a nursery-grown plant shall have a ball or root system 1/4 greater
in both diameter and depth than the nursery-grown plant for which it is substituted. The ball size shall be the average of the diameters measured 90 degrees apart (refer to Technical Standards for Tree Planting, Pruning and Removal Sec. 1, Tree Specifications)

K. Trees shall have a strong central leader. Trees that have a main trunk forming a “Y” (or codominant stem) shape are not acceptable. In no case will trees that have been topped be acceptable.

7. Pruning shall not be done prior to delivery except with specified written approval from UT Landscape Services. No pruning wounds shall be present with a diameter of more than 1” and such wounds must show vigorous bark growth on all edges. Dead or damaged branches or cross-over growth shall be removed (refer to Technical Standards for Tree Planting, Pruning and Removal Sec. 1, Tree Specifications)

L. Inspection of plant materials as required by city, county, state or federal authorities shall be the responsibility of the Contractor, who shall have secured permits or certificates prior to delivery of plants to site.

M. Plants are subject to inspection and approval or rejection at nursery source or on project site at any time before or during progress of Work for size, variety, condition, latent defects and injuries. Remove rejected plants from project site immediately.

2.3 MULCH

A. Mulch material shall be shredded hardwood bark. It shall be of such nature that adequate protection is provided against sun baking and quick drying out of the soil and shall not impede aeration or water penetration nor deplete the soil nitrogen. Mulch material shall be free of excess amounts of large leaves and sticks that would prevent proper dressing of the mulched surface, free of harmful substances and free of detrimental amounts of soil or other foreign matter that would promote early compaction, matting or deterioration of the mulch.

2.4 PLANTING SOIL MIXTURE (BACKFILL)

A. Tree planting backfill shall be native soil excavated from pit, mixed with pre-approved soil mixture.

B. The planting soil mixture shall be organic and shall consist of a soil mixture of 3/4 fine sandy loam and 1/4 compost, (Flower & Garden plus with composted soil or approved similar). The sandy loam shall be taken from a well-drained, arable site. It shall be free of subsoil, stones, clay, roots, weeds, grass or other objectionable debris, matter or toxic wastes.

C. Planting soil shall have a pH between 6.5 and 8.0 and a 1.5 to 3 percent organic content and no greater than a 500-ppm concentration of soluble salts.

2.5 PLANTING SOIL

A. Permeable soil shall be sandy loam, loamy sand or loam texture with a clay content of 10 to 25 percent. The soil must have an infiltration rate of at least 0.5 inches per hour and have a 1.5 to 3 percent organic content (Flower & Garden plus with composted soil or approved similar Organics by Gosh 512-276-1211)
B. Permeable soil shall have a pH between 6.5 and 7.5 and a 1.5 to 3 percent organic content and no greater than a 500-ppm concentration of soluble salts.

2.6 WATER DURING INSTALLATION OR STAGED ONSITE
A. Provide hoses, connections, and other equipment necessary to distribute water from source to required locations. Do not waste water or let it run into University thoroughfares.

2.7 ADDITIONAL SOIL AMENDMENTS – AS RECOMMENDED BASED ON SOIL TEST ANALYSIS:
A. Organic fertilizer such as Microlife 6-2-4 by San Jacinto Environmental Supply (713-957-0909), "Ladybug” 8-2-4 formula by The Natural Gardener (512-288-9740) or approved equal.
B. Root stimulator shall be Vitamin B-1 Medina, etc. and shall not contain synthetic fertilizer.

2.12 PLANTING ACCESSORIES (ONLY IF NECESSARY/REQUIRED)
A. Tree Stakes: Steel T-stakes, only stake trees if required or as specified by UT Arborist. If used, do not create trip hazards. Stakes shall be painted silver or as directed in the Drawings. Minimum height of stakes 48”.
B. Tree Ties: Wire of pliable galvanized zinc-coated iron of #10 gauge; provide a minimum of two (2) per tree.
C. Hose covering: 2-ply, reinforced, rubber garden hose, minimum of 1" diameter.
D. Tree Guard: 'ArborGard+' by DeepRoot, 1-800-458-7668 (or equal).
E. Tree stakes are to be removed 1 year after planting.
F. Any product used shall not damage plant material in any way.

PART 3 - EXECUTION

3.1 COORDINATION
A. Coordinate as required with other trades to assure their proper and adequate interface with Work of this section. Coordinate schedules for installation of Work with schedules for other installations in order to assure orderly progress of the total construction sequence.

3.2 EXAMINATION
A. Examine areas to receive landscape installation for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected

3.3 PREPARATION
A. Protect structures, utilities, sidewalks, pavements, and other facilities, and existing vegetation from damage caused by landscape installation operations.
B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water/sedimentation runoff or airborne dust to adjacent properties and walkways.
C. Soil Preparation for Shrub and Ground Cover Beds
1. Pre-Plant Weed Control
   a. If live perennial weeds exist on site at the beginning of work, spray with a non-selective systemic contact herbicide as recommended and applied by an approved licensed landscape pesticide applicator. Leave sprayed plants intact for at least fifteen (15) days to allow systemic kill. Apply herbicide in strict accordance with manufacturer’s instructions.
   b. Clear and remove these existing weeds by scraping or grubbing off all plant parts at least 1” below the surface of the soil over the entire area to be planted.

2. Backfill for Shrub and Ground Cover Beds
   a. Remove existing soil to an overall depth equal to ten (10) inches below finish grade.
   b. Till exposed soil to a minimum depth of six (6) inches.
   c. Add three (3) inches of expanded shale, if deemed necessary, and rototill to a depth of six (6) inches.
   d. Add three (3) inches of pH balanced compost and rototill to a depth of six inches.
   e. Mulch all planting areas when plant installation is complete with a minimum settled depth of three (3) inches of composted shredded hardwood mulch.
   f. Notify UT Landscape Services for soil inspection after initial excavation and prior to loosening the exposed soil.

3. At time of planting, all areas to be planted shall be free of stones, stumps, or other deleterious matter 1” in diameter or larger and shall be free from all wire, plaster or similar objects including construction debris that would be a hindrance to planting or maintenance.

D. Excavation Under Existing Trees to Remain:
   1. Soil shall not be excavated for soil preparation purposes from anywhere within the CRZ – Critical Root Zone of any existing tree which is to remain on site, unless approved by UT Arborist.
   2. UT Austin/Owner does not recommend any planting within CRZ of existing trees. Where the Planting Plan designates plantings to be added to the project under existing trees, outside the CRZ, the soil preparation in those areas shall be as follows:
      a. Air spade the soil loose to three (3) inch depth within the existing root system-no rototilling.
      b. Remove all weeds by hand once soil is loosened.
      c. Install one half (1/2) inches settled depth of compost to loose soil.
      d. Hand mix compost with loose native soil.
      e. Water beds to promote weed germination of dormant weeds and grasses
      f. Treat weeds in beds with an application of organic herbicide and hand pull.
      g. Remove weeds after recommended herbicide treatment period by hand digging.
      h. Remove rocks, loose root pieces, trash, dirt clods or other objects 1” and greater in size from the planting bed.

3.4 INSTALLATION

A. Planting shall occur only when weather and soil conditions permit, and in accordance with locally accepted practices, and as reviewed by UT Landscape Services.

B. Soil Compatibility Tests: Perform topsoil compatibility tests for pH and chemical contamination prior to completion of rough grading.
C. Site Preparation: Prepare site by applying contact herbicide to weed growth on site as per manufacturer’s label directions. Provide three (3) applications, each one week apart. Scarify planting areas to a minimum depth of six (6) inches. Float beds to grade and rake to remove weeds, clods, or rocks one (1) inch in diameter or greater. Thoroughly water-settle all soil.

D. Topsoil Installation:
1. Do not work soil when moisture content is so great that compaction will occur or when it is so dry that clods will not break readily. Apply water if necessary to bring soil to an optimum moisture content for filling and planting.

2. All compacted soils will be treated as necessary to provide adequate aeration.

E. Fine grading
1. Fine grade all planting areas. Provide incidental grading of all areas adjacent to curbs and sidewalks. Grade planting areas to a smooth, uniform surface plane with loose, uniform fine texture. Remove ridges and fill depressions to meet finish grades. Soil grades adjacent to paving, curbs or headers shall be adjusted for surface materials.

2. Maintain or provide positive drainage away from all building structures. Drainage flows shall not be impaired with obstructions.

3. Unless otherwise specified, final grade (at top of any surface materials) shall be set at 1 inch below adjacent paving, curb and headers for turf and planting beds unless shown otherwise.

4. Existing soil shall be graded to curbing with a 4 to 1 maximum slope.

F. Excavation of Plant Pits:
1. The Contractor shall not excavate plant pits more than 24 hours in advance of planting operations. Any plant pits left unattended for any length of time which may present a hazard shall be covered and/or clearly flagged as approved by the Engineer or designated representative. The walls and bottoms of all plant pits shall be scarified immediately prior to the placement of plants.

2. Pit Sizes: Planting holes may be dug by hand or by mechanical means and shall be circular or square (according to the shape of the root ball) with vertical sides, unless otherwise indicated on the Drawings. Trimming of the sides or bottom of the hole to uniform shape will not be required. Planting pit sizes shall be as follows, unless indicated otherwise on the Drawings:
   a. A minimum horizontal dimension of twelve (12) inches between the root ball and the sides of the planting pit for the following plant specifications:
      (1) Containers of fifteen (15) gallons or larger
      (2) Boxes of fourteen (14) inches or larger
      (3) Root ball diameter of Balled and burlapped or bag grown plants larger than fourteen (14) inches.
   b. A minimum horizontal dimension of two (2) times the diameter of the root ball for the following plant specifications:

Design & Construction Standards, April 2016
Containers less than fifteen (15) gallons
(2) Root ball diameter of Balled and burlapped or bag grown plants fourteen (14) inches or less

(c) A minimum diameter for bare-root plants to permit the roots to spread without crowding or curving around the walls of the pit.

d. Planting pits shall be excavated to a depth of at least 4 inches but not more than 8 inches greater than the depth of the root ball of balled and burlapped, containerized, container grown or bag grown plants; or the depth of the root system of bare-root plants. Pits dug to excess depths shall be backfilled and compacted to bring the pits to the specified depth. The depth of pits on slopes shall be measured at the lower side.

e. When performing mechanical transplanting, the receiving plant pit shall be backfilled as necessary with native or amended soil material as approved by UT Landscape Services.

f. Where holes are dug with an augur and the sides of the holes become plastered or glazed, this plastered or glazed surface shall be scarified.

3. Fill pits with water: Contact UT Representative if water does not percolate within 24 hours. Do not plant until proper measures have been taken to ensure appropriate percolation.

J. Pruning Roots

1. Root pruning shall be limited to the amount necessary to prune away broken and badly damaged roots. Any girdling roots on edge of rootball shall be cut with a handsaw or pruners. Severely girdled plants will be rejected on site.

L. Pruning

1. Pruning of plants shall be executed by certified arborist and shall conform to the best horticultural practice and shall be appropriate to the various types of plants and the special requirements of each. Plants otherwise acceptable, but with broken or badly bruised branches, shall have such branches removed with a clean cut. All cut surfaces ON OAK TREES ONLY over 1 inch (25 mm) in diameter shall be painted with an approved tree pruning compound.

2. Prior to the application of any tool to a tree, the tool must be sterilized. The tool does not need to be sterilized again until immediately prior to use on another tree.
   a. Oak Wilt Prevention Notes
      i) Avoid pruning or wounding oak trees from February through June
      ii) Pruning shall be done with sterilized, sharp tools. To prevent bark tears, the weight of the branch shall be removed before making final pruning cut.
      iii) Pruning cuts or damaged areas on an oak tree shall be painted within five minutes with a standard tree wound dressing or latex paint. Tree wound dressing shall be either treekote aerosol or tanglefoot pruning sealer (or approved equal).

M. Planting and Backfilling
1. Topsoil from the planting hole may be used for backfilling provided it is kept separate from subsoil and rendered loose and friable. Additional topsoil required to backfill the holes shall be furnished. (See products section).

2. In general the top of any tree’s root ball shall stand after settlement of the backfill approximately level with or 1” above finish grade. Shrubs shall be planted with the root ball flush with the level of settled backfill unless specifically noted otherwise specified. Unless indicated otherwise or approved otherwise by the UT Landscape Services or designated Representative, planting and backfilling shall be as follows:

3. Depth of Transplanting
   a. In general, plants shall be installed and covered with top soil approximately one (1) inch (25 mm) above the top of the root ball or container soil surface.

4. Balled and Burlapped Plants
   a. Plants of this type shall not be handled by the stems nor in such manner that the soil of the ball may be loosened. A saddle around the ball should be used for lifting. No plastic burlap material will be allowed. The burlap shall not be removed from the ball. After the plant has been placed in the proper position, as shown on the Drawings, loose friable backfill shall be worked about the ball in 12 inch lifts until the pit is two-thirds (2/3 full). The burlap shall then be opened on top of the root ball to expose the top one-third (1/3) of the root ball. The pit shall then be filled with water and the backfilling completed, working the backfill and water well to prevent any air pockets.

   b. For ball supporting devices such as wire baskets, the basket shall not be removed. The plant shall be placed in the prepared planting pit in the proper position and backfill shall be placed around the ball until the pit is about one-third (1/3) full. The basket shall be carefully removed to just above the backfill, leaving the bottom portion intact. Remove all other non-biodegradable materials such as twine, nylon bagging, and the like. Backfilling shall be completed as described above.

5. Containerized or Container Grown Plants
   a. At the time of planting the root ball and plant shall be carefully removed from the container to prevent damage to the plant and root ball. If in the opinion of the Landscape Architect or designated UT representative a sufficient amount of soil has fallen off or the ball has been broken to such an extent as to reduce the chances of the plant to grow, the plant will be rejected. Container plants shall be acclimated to outside growing conditions. Container plants shall be placed and backfilled in the same manner as balled and burlapped plants. Any girdling roots on edge of rootball shall be cut with a handsaw or pruners.

N. Vegetative Watering

1. During the planting operations, the Contractor shall keep the ground and backfill material moist to at least 12 inches around the root ball. The Contractor shall be required to meet the minimum watering requirements shown on the Drawings for all circumstances by a method approved by the Landscape Architect. When an
irrigation system is shown on the Drawings, the Contractor shall coordinate his work to insure that the irrigation system is operational as the plants are installed.

O. Pruning

1. Plants shall not be pruned immediately before delivery to the work site, unless approved by UT Landscape Services. Common nursery pruning practices are acceptable. Any necessary pruning shall be done at the time of planting as approved by the UT Landscape Services and shall be appropriate to the various types of plants and the special requirements of each.

3.5 CLEAN-UP

A. Remove all waste and debris; clean all pavement of soil and mulch created by this work from site.

3.6 DISPOSAL

A. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, debris, and legally dispose of them off Owner’s property at Contractor’s expense.

3.7 MAINTENANCE AND PROTECTION

A. Comply with Section 32 0190 – Operation and Maintenance of Planting.

END OF SECTION 32 90 00
SECTION 32 92 00 – TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor and materials necessary for installation of turf sod and other related work as required.

B. Related work described elsewhere:
   a. Section 32 84 00 – Planting Irrigation
   b. Section 32 90 00 – Planting
   c. Section 32 01 90 – Operation and Maintenance of Planting
   d. Section 01 81 13 – Sustainable Design Requirements – LEED

1.2 SUBMITTALS

A. Following the Sustainable Sites guidelines, for products that are extracted, harvested or recovered and manufactured from within 250 miles of Project. Indicate location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw or recycled material. Include statement indicating costs for each product that is regionally extracted, harvested or recovered and manufactured.

B. Submit sod growers certification of grass species stating botanical name and common name. Identify source location.

C. Submit required material samples and certifications.

D. Submit the following materials certification: Fertilizer analysis.

E. Submit soil test report. (Texas Plant and Soils Lab, Edinburg, TX (936-383-0739)

F. Submit one-pound samples of each material specified in this section with certified laboratory analysis of each sample as follows:
   1. Topsoil from on-site
   2. Imported Topsoil
   3. Root/Soil Conditioners

1.3 QUALITY ASSURANCE

A. Provide and pay for materials testing. Submit name of testing agency for approval by UT Representative (Texas Plant & Soils Lab).

B. A certified laboratory retained by the contractor shall provide testing and verification of representative common area turf material samples proposed for use on this project. Testing includes, but is not limited to, the following:
   1. Plasticity index
   2. Soil pH
   3. Particle size, percentage soil texture
   4. Percentage organic material
   5. Nutrient level analysis
      - macro, secondary and micro nutrients
      - Nitrate
      - Potassium
- Phosphorous
- Calcium
- Magnesium
- Sodium
- Percolation rate
- Conductivity

D. Based on above testing, laboratory shall make recommendations on type and quantity of amendments required to bring levels into acceptable ranges as detailed in Part 2 – Products and Materials of this section.

E. No later than 30 days after Notice to Proceed, submit to UT Representative for approval documentation confirming seed has been ordered from a recognized seed supplier.

1.4 DELIVERY, STORAGE AND HANDLING

A. Cut, deliver and install sod within 24 hour period. Only deliver what can be installed within 24 hour timeframe.

B. Deliver fertilizer materials in original unopened containers, showing weight, analysis, and name of manufacturer. Store in manner to prevent wetting and deterioration.

C. Provide bulk materials processed and blended off-site when specified. Deliver materials in clean, washed, and covered trucks to eliminate contamination during transportation. Coordinate on-site stockpiling locations with Owner. Stockpile in areas free of debris and away from drainage routes. Cover bulk material with plastic or geotextile if material is to be stockpiled more than 24 hours.

D. Protect sod from sun, wind and dehydration prior to installation. Do not tear, stretch, or drop sod during installation.

1.5 PROJECT CONDITIONS

A. Sod and the Planting Plan: Sod shall not be designed/planted under any existing trees. No exceptions.

B. Work notifications: Notify UT Representative at least 7 working days prior to start of sod installation.

B. Protect existing utilities, paving, and other facilities from damage caused by sod installation.

C. Install sod only after planting and other work affecting ground surface has been completed.

D. Restrict traffic from lawn areas until grass is established. Erect signs and barriers as required.

E. Provide hose and lawn watering equipment as required.

F. Ensure irrigation system is installed prior to sod installation. Locate, protect, and maintain irrigation system during turf installation. Repair damage to irrigation system components during turf installation.

1.7 WARRANTY

A. Refer to Section 32 01 90 - Operation and Maintenance of Planting
PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. All plants and raw materials shall be manufactured and/or extracted or harvested within 250 miles of Project site and all recycled or salvaged materials shall be manufactured and recovered within 500 miles of Project site.

2.2 MATERIAL

A. Sod: Acceptable Varieties of Sod for the UT-Austin campus:

1. Class/Grade of Sod and Composition:
   a. Zoysia ‘Palasaides’
   b. Bermuda ‘Celebration’
   c. Turf shall be classified as certified stock or shall originate from certified stock.

2. Sod shall be 98% insect free grown in sandy loam based soil, within 250 miles of UT Austin campus, preferably with

3. Thickness of Cut: Bermuda ‘Celebration’ or Zoysia ‘Palasaides’ shall be machine cut at a uniform soil thickness of 0.60 inch (15 mm), plus or minus 0.25 inch (6 mm), at the time of cutting, unless otherwise agreed upon. Measurement for thickness shall exclude top growth and thatch.

4. Pad Size: Sod shall be supplied in 24” wide standard rolls with clean cut edges. Maximum allowable deviation from standard widths and lengths shall be plus or minus 0.5 inch (15 mm) on width and plus or minus five percent on length. Broken pads and torn or uneven ends will not be acceptable.

5. Strength of Turf Sod Sections: Standard size sections of turfgrass sod shall be strong enough that it can be picked up and handled without damage.

6. Moisture Content: Bermuda ‘Celebration’ or Zoysia ‘Palasaides’ shall not be harvested or transplanted when its moisture content (excessively dry or wet) may adversely affect its survival.

7. Mowing Height: Before harvesting, Celebration® Bermudagrass shall be mowed uniformly at the following height: 0.5 to 1.5 inches.

8. Time Limitations: Sod shall be harvested and delivered within a period of 24 hours.

9. Sod shall be installed/transplanted as soon as possible after delivery, unless a suitable preservation method is approved prior to delivery.

10. Sod not transplanted shortly after delivery shall be inspected and approved by UT Landscape Services prior to its installation.

11. Diseases, Nematodes and Insects: shall be free of diseases, nematodes and soil-borne insects. Specific nursery and/or plant materials laws may require that all sod entering inter-state commerce be inspected and approved for sale. The inspections and approval must be made by the appropriate government representative of the agriculture department or office of entomologist.

12. Weeds: Field Grown sod shall be 100% free of all noxious weeds. Field shall be considered free of grassy and broad leaf weeds. Sod containing common nutgrass, dandelion, or other deleterious weeds will not be accepted.

B. Water: Free of substance harmful to turf growth. Furnish hoses or other methods of transportation as required.

C. Import Topsoil

1. Composition of topsoil shall be as follows:

   Silt: 20-30%
   Clay: 20-30%
   Sand: 40-45%
   Organic material (natural or otherwise): 2% maximum
pH: 6.5-8.0
Soluble salts: less than 700 ppm.
Nutrients: enough to bring to levels of acceptable plant growth

2. Topsoil shall not have a mixture of subsoil and shall contain no slag, cinders, stones, lumps of soil, sticks, roots, trash or other extraneous materials larger than 1.5 inches (40 mm) in diameter. Topsoil must also be free of viable plants or plant parts of common bermudagrass, quackgrass, johnsongrass, nutsedge, poison ivy, thistles, or others as may be specified. All topsoil shall be tested by a reputable laboratory for pH and soluble salts. If needed, pH correction material shall be applied at a rate sufficient to correct the pH to a range of 6.5 to 7.5. Soluble salts shall not be higher than 700 parts per million.

3. No sod shall be placed on soil which has been chemically treated until sufficient time has elapsed to permit dissipation of all harmful materials (see manufacturers recommendations for re-entry date calculation). The general contractor shall assume full responsibility for any loss or damage to Bermuda ‘Celebration’ or Zoysia ‘Palasaides’ arising from improper use of chemicals or due to his failure to allow sufficient time to permit dissipation of chemical residues, whether or not such materials are specified herein.

4. Submit to UT Landscape Services proposed source or sources of topsoil at least 15 working days prior to delivery. Obtain soil samples from his intended topsoil source and have soil analysis performed by soil testing laboratory to ensure conformity with specification. Do not deliver topsoil to site prior to approval by UT Landscape Services.

5. Percolation rate: between 3 to 4 inches per hour.

D. Commercial Grade Fertilizer – AS REQUESTED BY UT REPRESENTATIVE BASED ON SOIL ANALYSIS
   1. Fertilizer:
      i. Organic by The Natural Gardener (8-2-4) or approved equal

E. Soil Amendments – AS REQUESTED BY UT REPRESENTATIVE BASED ON SOIL ANALYSIS

F. Pre-emergent herbicide – AS REQUESTED BY UT REPRESENTATIVE. Notify UT Landscape Services of proposed pre-emergent herbicide prior to application.

PART 3 - EXECUTION

3.1 INSPECTION
   A. Examine finish surfaces, grades, topsoil quality, and depth. Do not start sod installation until unsatisfactory conditions are corrected.

3.2 PREPARATION
   A. Limit preparation to areas that will be immediately planted.
   B. Scarify existing soil surface and cultivate to minimum 8-inch depth to alleviate compaction from site excavation work. Remove debris, stones over ½-inch in diameter, sticks, roots, rubbish, and other extraneous materials and dispose of off site. Rototill to thoroughly incorporate following soil amendments into top 6-inches of scarified soil:
1. Soil conditioner/compost (as defined in Section 2.2 E) - 2 inches deep, (approx. 6 cubic yards / 1,000 SF)
2. Fertilizer (as defined in Section 2.2 D) –
   I. Microlife 6-2-4
   II. Ladybug 8-2-4
   III. Humates 0-0-4 (Microlife) Carbon
3. Fine grade

C. The topsoil shall be uniformly distributed on the designated area(s) and it shall be a minimum of 6 inches (75 mm) deep after firming. Spreading shall be performed in such a manner that sod installation can proceed with a minimum of additional soil preparation and tillage. Any irregularities in the surface resulting from topsoil removal or other operations shall be corrected in order to prevent the formation of depressions or water pockets. Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed for turfgrass sod installation.

D. A licensed chemical applicator shall treat lawn areas with ‘Round Up’ by Monsanto, or approved equal, per label directions as required to kill existing vegetation at least 30 days prior to turf installation.

E. Grade turf area to smooth, even surface with loose, uniformly fine texture. Roll, water settle, rake to remove ridges and fill depressions to meet final grade.

F. Restore prepared area to specified condition if eroded, settled, or otherwise disturbed after fine grading and prior to installation of turf.

G. Weeds shall be removed by hand throughout the duration of warranty period or until project is turned over to UT Landscape Services.

3.3 INSTALLATION

A. Sod Installation

1. Transplant sod when temperatures are above 65 degrees F.
2. Lawn areas should be weed free, smoothly raked seedbed.
3. Time Limitations: Sod shall be transplanted/installed as soon as possible following delivery, unless a suitable preservation method is approved prior to delivery. Sod not transplanted shortly after delivery shall be inspected and approved by the Landscape Architect prior to its installation.

4. Transplanting:
   a. Moistening the Soil: After all unevenness in the soil surface has been corrected, the soil shall be lightly moistened immediately prior to installation of sod.
   b. Starter Strip: The first row of sod shall be laid in a straight line, with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered to promote more uniform growth and strength. Care shall be exercised to insure that the pieces are not stretched or overlapped and that all joints are butted tightly to prevent voids that would cause air drying of the roots.
   c. Sloping Surfaces: On 3:1 or greater slopes, traditional size (1 sq yd / 1 sq m) Sod shall be laid across the angle of the slope (perpendicular), with staggered joints and secured by tampering, pegging, stapling or other approved methods of temporarily securing each piece. Large-roll sod shall be laid in the direction of the slope, with temporary securing being at the discretion of the installation contractor.
d. Swales and Intermittent Waterways: The installation of turfgrass sod within drainways or intermittent waterways shall be determined after considering maximum channel velocities for storms of a designated intensity. Traditional size sod shall be laid perpendicular to the direction of flow and pegged to resist washout during the establishment period, while large-roll pieces shall be laid in the direction of the flow, with temporary securing being at the discretion of the installation contractor.

e. Watering and Rolling: The installation contractor shall water the sod immediately after transplanting to prevent excessive drying during progress of the work. As sodding is completed in any one section, the entire area shall be lightly rolled in (2) different directions to ensure good contact with subgrade. It shall then be thoroughly watered to a depth sufficient that the underside of the new sod pad and soil immediately below the pad are thoroughly wet.

3.5 MAINTENANCE AND PROTECTION

A. See Section 32 01 90 Operation and Maintenance of Planting.

3.6 ACCEPTANCE

A. See Section 32 01 90 Operation and Maintenance of Planting.

3.7 CLEANING

A. Perform cleaning during installation and upon completion of work. Remove excess materials, debris, and equipment. Repair damage resulting from turf installation.

END OF SECTION 32 92 00
These requirements and specifications shall pertain to all construction projects on The University of Texas at Austin (UT-Austin) campus, including The University of Texas Systems Projects (Office of Facilities Planning and Construction, OFPC), and UT-Austin Project Management and Construction Services, PMCS. All trees on campus fall under this provision. Projects primarily fall under OFPC or PMCS but these standards and specifications shall apply to all trees on main campus and the Pickle Research Center campus (PRC).

Damage to trees is not always visible. Impacts to the root systems of trees are common on construction sites, and may not be immediately apparent; trees can show signs of decline years after root damage occurs. It is for this reason that this specification addresses damage prevention as it pertains to construction parameters. This specification also details requirements for workers on site—areas off limits for parking, storing equipment, etc. The goal is to address conflicts before they arise and before start of work.

Failure to adhere to these standards and specifications shall result in work stoppage (in the affected work area).

1.00.0 Definitions

- **Caliper Inch**: is the diameter of a young tree. It is measured 6” above ground for trees up to and including 4” caliper size. If caliper at 6” above ground exceeds 4” caliper, the tree will then be measured at 12” above the ground. Newly planted (nursery stock) trees on the University of Texas at Austin campus are measured in caliper inches.

- **Critical Root Zone (CRZ)**: an area from the base of the tree that extends beyond the drip line. It is equal to 1 foot radius for every inch of stem diameter. This minimum area is needed for tree and root health and stability.

- **Damage or damaged**: A tree is considered “damaged” when a physical/mechanical action damages parts of the stem, canopy or roots.

- **Diameter at Breast Height (DBH)**: a standard method of measuring stem diameter 4.5 feet above the ground. Established trees on The University of Texas at Austin campus are measured in DBH inches.

- **Drip Line**: Considered the outer edge of the tree canopy. An imaginary vertical point that extends from the canopy edge to the ground.

• Landscape Services (LS) representative: urban forester, staff arborist (or designee by UT – Austin landscape services).
• Owner: TBD by project scope
• Owner’s representative: TBD by project scope but usually an OFPC or PMCS project manager.
• Replacement Tree: A self-supporting tree on the UT Austin Desirable Tree Species list that meets caliper inch requirements.
• Tree Survey: Part of the construction plans; contains tree tag number, location of trees (GPS located if possible), DBH, species, and drip line (if possible).
• Tree Protection Plan: A written part of the construction plans that describes measures to protect trees during all phases of the project; it should include details, notes, location of tree protection fence, and any other applicable items.

2.00.0 Preconstruction Requirements
An ISA Certified Arborist http://www.isa-arbor.com/certification/index.aspx shall manage any contract work dealing with trees on The University of Texas at Austin campus. All tree care activities shall require at minimum, an ISA Certified Tree Worker to be on site at all times. UT-Austin tree-related construction standards and specifications can be found on the PMCS website at: http://www.utexas.edu/pmcs/dcstandards/ Additional construction details for trees are forthcoming.
Trees to be planted and managed on construction sites at The University of Texas at Austin shall adhere to specifications based on the most recent editions of the following:
2.00.1 American National Standards Institute (ANSI) Z60.1-2013
2.00.2 ANSI A300-01 Pruning (2014)
2.00.3 ANSI A300-02 Soil Management (Fertilization) (2011)
2.00.4 ANSI A300-05 Management of Trees and Shrubs during Site Planning, Site Development, and Construction (2012)
2.00.5 ANSI A300-06 Planting and Transplanting (2012)
2.00.6 ANSI A300-08 Root Management (2013)
2.00.7 Related ISA Best Management Practices (BMP’s)

2.01.0 Pre-Construction Conference
A pre-construction meeting with the Owner’s Representative shall be set at least seven days before start of work to review any questions the Contractor may have regarding the work, administrative procedures during construction, and project work schedule. This meeting shall include a UT – Austin LS representative.
2.01.1 The following Contractors shall attend the preconstruction conference:
2.01.11 General Contractor
2.01.12 Consulting Arborist
2.01.13 Subcontractor assigned to install Tree and Plant Protection measures
2.01.14 Earthwork Contractor
2.01.14 All site utility Contractors that may be required to dig or trench into the soil.
2.01.15 Landscape subcontractor
2.01.16 Irrigation subcontractor

2.02.0 Development Site Tree Assessment
2.02.01 The UT Arborist shall provide a tree evaluation of trees on site. This will be communicated to OFPC, PMCS and other applicable UT departments prior to any site preparation beginning. The project may provide an assessment from an outside arborist (ISA Certified Arborist, or ASCA Registered Consulting Arborist (RCA); this assessment shall include all potential tree pruning, removals, health care, or transplanting and must be approved by the UT arborist. A written report and map including the current condition of the tree shall be provided.

2.03.0 Tree Survey
2.03.1 Any outside tree survey shall use the existing University of Texas at Austin tree inventory tag numbers. If a tree is missing a tag or has a number that is illegible or not intact, then a new number can be assigned and tagged on that tree. Inform UT Arborist of these changes. Do not remove existing tree tag numbers. If needed, UT Arborist shall provide tree inventory data for project area. 2.03.2 All trees 8” DBH and greater on all development sites shall be surveyed and shown on the site plan. Survey criteria shall state tree number, species, and tree DBH, and shall cross-reference existing tree numbers. Any tree survey must be vetted by the UT Arborist prior to the issuance of construction documents.

2.04.0 Critical Root Zone Determination (CRZ):
The UT Arborist will coordinate specific requirements regarding scaffolding, construction traffic, build back, forms, foundation or any other issues as they relate to CRZ. These standards act as the minimum amount of preservation required:
2.04.1 1 foot of radial protection per diameter inch of tree shall determine CRZ (i.e., a 20” tree would have a 40 foot diameter CRZ; see chart below)
2.04.2 Areas:
   2.04.21 A quarter of CRZ means no impact is allowed
   2.04.22 Half of CRZ means no cut or fill greater than 4’ is allowed (i.e., for a 20” tree it would be 20ft in diameter)
   2.04.23 Total CRZ needs to be preserved by at least 50%

<table>
<thead>
<tr>
<th>Tree diameter, DBH (inches)</th>
<th>Critical Root Zone, CRZ (feet)</th>
</tr>
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<tbody>
<tr>
<td>8 inches</td>
<td>16 feet</td>
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<td>10 inches</td>
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<td>40 inches</td>
<td>80 feet</td>
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</table>
2.05.0 Tree Protection Fencing
All trees and natural areas shown on plan to be preserved shall be protected with temporary chain-link fencing. In areas where installation of chain-link fencing would be detrimental to a tree or a tree’s root system, other methods of fencing may be acceptable per approval from UT Arborist (i.e., Chain-link panels, plastic fencing, etc.).

2.05.1 Protective fences shall be erected according to The University of Texas at Austin standards for tree protection.

2.05.2 Protection fencing shall be installed prior to the start of any site preparation work (clearing, grubbing grading) and shall be maintained throughout all phases of the construction project until the final walk-through is performed unless prior approval is sought through UT Arborist.

2.05.3 Tree protection fencing that is damaged or found to be non-compliant shall be repaired/replaced within 24 hours of notice or a stop work order shall be given.
2.05.4 Erosion and sedimentation control barriers shall be installed or maintained in a manner that does not result in damage to the tree or Critical Root Zone (CRZ) and in a manner that does not result in soil buildup.

2.05.5 Protective fences shall surround the trees or groups of trees, and will remain at the location specified in the approved site plan. For natural areas, protective areas shall follow the limit of construction line in order to prevent the following:

- 2.05.51 Soil compaction in the root zone area as a result from vehicular traffic or storage of equipment and materials.
- 2.05.52 Root zone disturbances due to grade changes (greater than 4 inches of cut or fill), or trenching not approved or authorized by the UT Arborist.
- 2.05.53 Wounds to exposed roots, trunk or limbs by mechanical equipment.
- 2.05.54 Other activities detrimental to trees such as chemical storage, concrete clean-outs and other construction spoils.

2.05.6 Exceptions to installing fences at CRZ shall be permitted in the following cases:

- 2.05.61 Where there is to be an approved grade change, impermeable paving surface, tree well, or other such site development, erect the fence 2 to 4 feet beyond the area disturbed.
- 2.05.62 Where permeable paving is to be installed within a tree’s CRZ, erect the fence at the outer limits of the permeable paving area (prior to site grading so that the area is graded separately prior to paving installation to minimize root damage).
- 2.05.63 Where construction activities come within 6 feet of any tree, protection of the trunk with strapped on planking to the height of 8 feet (or the limits of lower branching) may be required in addition to the reduced fencing provided.
- 2.05.64 Where trees are close to proposed buildings, erect the fence so there is 6 to 10 feet of workspace between the fence and the building.
- 2.05.65 Where there are severe space constraints due to limits of construction (LOC) or other special requirements contact the UT Arborist.
- 2.05.66 Special Note: For the protection of natural areas, fences are required. No exceptions.

2.06.0 Tree Transplant Specifications

2.06.1 Trees suitable for transplanting and their future locations shall be designated on site plan and marked on site at least six months prior to commencing site preparation activities.

2.06.2 Tree transplant contractor should be allowed at least 90 days lead time for root pruning activities prior to moving trees.

2.06.21 It is recommended that trees be moved between the months of October and February, if possible.
2.06.3 Final grading and elevation of transplant trees shall be confirmed prior to final issuance of construction documents.

2.06.4 Coordination of logistics for movement of transplant trees shall include OFPC, general contractor, engineer, and UT Arborist.

2.06.5 Transplanting of trees shall be done in a manner that is industry standard (e.g., time-tested practices etc.). UT Arborist shall approve these means and methods.

2.06.6 The tree transplant contractor or landscape subcontractor shall maintain all transplanted trees during construction and for an additional twelve months following substantial completion.

2.06.61 To include irrigation, mulching, erosion control, weed control, insect and disease, and any other necessary plant care activities.

2.06.62 If a tree fails to survive the above timeframe, a new tree(s) will be provided by the project (must meet the mitigation requirements in section 5.00).

2.06.7 Construction activities shall not take place within five (5) feet of the edge of any transplant tree root ball.

2.07.0 Tree Removal and Repurposing Specifications

2.07.1 Trees approved for removal shall be removed in a manner that does not impact trees to be preserved. Reference Technical Standards Subsection 3.00.0.

2.07.2 Contractor performing tree removal shall coordinate with UT Arborist to remove selected trees in a manner that will enable them to be processed into usable materials.

2.07.3 Contractor will transport trees removed for repurposing to a local UT property (exact location TBD).

3.00.0 Tree Protection During Construction

3.01.0 Projects on The University of Texas at Austin shall adhere to specifications based on the most current editions of the following:


3.01.2 ANSI z133.1 Safety Standards

3.01.3 Related ISA Best Management Practices (BMP’s)

3.02.0 Trees within LOC are ultimately the property of The University of Texas at Austin. All attempts shall be made to ensure survivability of trees in regards to construction impacts. Including:

3.02.1 Continuous inspection of tree protection fencing installed per university specifications and approved site plan (by UT arborist and general contractor).

3.02.2 Any encroachments into tree protection fencing and CRZs shall be brought to the attention of the project manager and/or construction inspector, UT Arborist, or Landscape Services representative. Refer to section 2.05.3
3.02.3 Deviations from approved tree preservation plans will occur only with written authority from UT Arborist or UT Landscape Services Representative.

3.03.0 Critical Root Zone Management
Any roots two inches (2") or greater severed by construction activities shall be pruned flush with the soil. Roots severed shall be backfilled with quality soil or compost as soon as possible. Cuts to oak roots shall be made using disinfected tools and painted when finished. If exposed roots are not backfilled within 48 hours, cover them with organic material in a manner that reduces soil temperature and minimizes water loss due to evaporation. Excavations within CRZ shall be first assessed by means of air excavation. Utilizing a compressed air tool significantly decreases damage to roots. Locating roots using this method allows for proper root pruning and preservation techniques that will increase the chance of survival of the tree.

3.03.1 Air Excavation Specifications:
3.03.11 A compressor-powered air excavation tool shall be used to “pot-hole” (probe soil to certain depth in search of root material) proposed excavation areas.
3.03.12 Roots 2” and greater will be exposed and cut cleanly back to existing soil (wound paint and disinfected tools required for all oaks).
3.03.13 A quality topsoil and/or compost shall be used as backfill in areas where roots are present.
3.03.14 Coordinate with the requirements of the proposed Planting Soil section for modifications to the soil within the root zone of existing trees.

3.03.2 Any trenching required for the installation of landscape irrigation shall be installed as far from existing tree trunks as possible, and must be outside of quarter CRZ.

3.03.3 No soil greater than 4 inches shall be permitted within the half CRZ of trees. No soil or mulch is permitted on the root flare of any tree.

3.03.4 Pruning to provide clearance for structures, vehicular clearance and equipment shall take place before damage occurs (ripping of branches etc.).

3.03.5 All pruning shall be performed to ANSI A300 - 01 Pruning Standards (2014), ANSI Z133.1 Safety Standards, and be completed by tree care professionals with a minimum of an ISA Certified Tree Worker on site. No more than 25% of the tree may be pruned. Anything above 25% must be approved by UT Arborist.

3.03.6 UT Arborist shall approve any modifications to the tree protection plan.

3.03.7 Removal of Hardscape Areas from CRZ
Special care shall be taken when removing sidewalks, streets, pavers, etc., from within CRZ. This will include but not be limited to:
3.03.71 Saw cutting and hand removal of materials within CRZ
3.03.72 Reduced heavy equipment access within CRZ
3.03.73 Installation of mulch (4-6 inches) within CRZ for root protection

3.03.8 Installation of Ground Protection Mats or Mulch
3.03.81 Areas where foot traffic or storage of lightweight materials is unavoidable, provide a layer of 4-5 inches of wood chips or mulch.
3.03.82 Areas where heavy vehicle traffic is unavoidable provide a layer of 6-8 inches of wood chips or mulch and add ground protection mats on top.
3.03.9 Concrete Washout areas shall be outside of CRZ.

3.04.0 Irrigation Standards for Trees Preserved on Site
In order to minimize impacts of construction, trees located within LOC and slated for preservation shall continue to receive the necessary levels of irrigation to ensure survival. Coordination must be made between UT-Landscape Services Irrigation staff and the general contractor.
3.04.01 Trees within preservation zones will continue to be irrigated through duration of project.
3.04.02 Irrigation systems shall be continually monitored to ensure correct coverage.
3.04.03 If irrigation service is interrupted, water shall be provided by the general contractor. Water barrels, tree gators and water trailers/tankers are suitable substitutes.

3.05.0 Maintenance of CRZ Areas within LOC
Contractors shall be responsible for grass and weed maintenance inside LOC and tree protection fence areas.
3.05.01 Grass will remain trimmed inside all tree protection fencing, work shall be performed on the same frequency as surrounding area.
3.05.02 Routine hand weeding is required for all mulch areas located within the tree protection zone.
3.05.03 Trash inadvertently deposited within tree preservation zones shall be removed prior to trimming or mowing.

3.06.0 Tree Inspections
To ensure compliance of tree preservation, a UT Arborist, UT- Landscape Services representative, or a project appointed arborist, shall conduct regular inspections. Frequency based on project needs. If project has a consultant arborist, inspections shall be monthly at minimum. Reports shall be provided to the university project manager and sent to all parties. Inspections shall include:
3.06.01 Tree preservation zone encroachment
3.06.02 Structural integrity of tree protection fencing
3.06.03 Irrigation/soil moisture levels
3.06.04 Evidence of plant stress
3.06.05 Insects and disease activity
3.06.06 Dust levels on leaves
5.00.0 Tree Mitigation Policy

5.01.0 Heritage Trees

5.01.1 Heritage Trees (24” DBH and above) shall not be removed without a review process, except those species listed in section 5.04.2 below. That review will take into account the following:

5.01.12 Current health of the tree (tree is dead, tree is a risk, or tree is diseased)

5.01.121 UT Arborist shall determine current condition of tree. If tree is dead, diseased, or poses a risk, UT Arborist will evaluate and this will affect mitigation requirements.

5.01.13 Final approval will be determined by the Director of Facilities Services for UT- Austin.

5.01.2 Trees shall be replaced on a 3” to 1” ratio (i.e., if you have removed a 24” DBH tree, 72 caliper inches must be replaced). See section 1.00 for difference between DBH and caliper.

5.02.0 8”- 23.9” DBH Trees

5.02.1 Trees shall be replaced on a 1” to 1” ratio, except those species listed in section 5.04.2 below. For example: a 20” diameter tree will be replaced by 20 caliper inches; this could mean five, 4” trees or ten, 2” caliper trees.

5.03.0 Trees less than 8” in diameter require no replacement for any species. (see section 6.01.4 for preservation credits).

5.04.0 Species

5.04.1 The following species are required to be replaced:
All Native Texas Oaks, American Elm, American/Mexican Sycamore, Ash Sp., Bald Cypress, Bigtooth Maple, Black Walnut, Cedar Elm, Mexican Plum, Montezuma Cypress, Pecan, Southern Magnolia, and Texas Persimmon.

5.04.2 The following species are not required to be replaced on any site:

5.05.0 Memorial Trees

5.05.1 Various memorial trees exist throughout The University of Texas at Austin campus. The project shall attempt to preserve in place or transplant any memorial trees on the site. The university reserves the right to remove or relocate trees in an unforeseen circumstance. If a tree cannot be relocated due to restrictions of tree size and available planting locations, the tree will be removed and replaced with a new one at the discretion of the UT Arborist. The first option shall be to replace on site if space is available; costs to be covered by the project.

5.06.0 Trees with Historical Significance

5.06.1 The project shall make every attempt to preserve in place or transplant any trees with historical significance within LOC. The university reserves the right to remove or relocate trees in an unforeseen circumstance. If a tree cannot
be relocated due to restrictions of tree size and available planting locations, the tree will be removed and replaced with a new one(s) at the discretion of the UT Arborist. The first option shall be to replace on site if space is available; costs shall be covered by the project.

6.00.0 Tree Replacement Requirements
6.01.0 Tree mitigation shall be required when the above sizes of trees are removed. Examples shall include one or more of the following mitigation measures:

6.01.1 Planting replacement trees on the site in accordance with the latest edition of the American Standard for Nursery Stock (ANSI Z60.1).
6.01.2 Transplanting existing trees on site or nearby. Any transplant tree can count 50% toward total mitigation; for example: a 30” diameter oak would count toward 45 inches of required mitigated inches (due to heritage trees being replaced 3:1).
6.01.3 If above options have been exhausted, trees shall be planted at other available locations on main campus, other local UT properties, or with a local tree non-profit.
6.01.4 All trees (from section 5.04.1) below 8” diameter that are preserved on site will count 50% toward total mitigation; for example: five 6” elm trees are preserved on the perimeter of the site – this would count toward 15 inches of required mitigated inches.

6.02.0 Quantities of Replacement Trees
6.02.1 Existing tree inches are calculated in DBH inch but replacement trees are calculated in caliper inch (i.e.: 20” DBH tree removed equals 20 caliper inches replaced).
6.02.2 Size of trees replaced on development sites should range between 1” and 4” in caliper. Trees greater than 4” may be planted if feasible and approved by UT Arborist.
6.02.3 Replacement trees shall be planted to the extent on the site without jeopardizing spacing requirements for future growth of the trees, or impacting existing tree canopy.
6.02.4 Newly planted trees on development projects shall be spaced in the following manner:
   6.02.41 Large trees shall be planted at least 30 feet off center
   6.02.42 Medium sized trees shall be planted at least 20 feet off center
   6.02.43 Small sized trees shall be planted with proper spacing per species
6.02.5 Types and sizing of replacement trees: refer to the UT Austin Desirable Tree Species List:
   *Disclaimer: Riparian restoration projects may have a different list of desireable species.
6.02.6 A minimum of 5 different species from the UT-Austin Desirable Tree Species List should be planted if more than 100 caliper inches is required. No more than 30% of one species should be planted.
6.02.7 Newly planted trees should have the following available soil volumes:
   6.02.71 Large trees (from desirable species list) - 1,000 ft³
   6.02.72 Medium trees – 500 ft³
   6.02.73 Small trees (ornamental) – 275 ft³

6.03.0 Planting Season Requirements
   6.03.1 Optimal tree planting window in Central Texas is typically from October through March. Projects shall consider this during the site plan process. If possible, landscape installations should be held to that time frame. Signage and education materials can be used to assist in this area. Consider minimal plantings to suffice until planting season.
Examples of tree protection details for construction documents:
Technical Standards for Tree Planting, Maintenance and Removal

1.00.0 Tree Planting Specifications and Design

1.01.0 Projects on The University of Texas at Austin shall adhere to specifications based on the most recent editions of the following for tree planting:

(*Any excavation work shall contact Texas 811 prior to digging; you may also contact UT Location Information Services at lis@austin.utexas.edu for additional information on UT utilities.)

1.01.1 American National Standards Institute (ANSI) A300 – 06 Planting and Transplanting Standards (2012)

1.01.2 American National Standards Institute (ANSI) Z60.1-2013, standards for nursery stock

1.01.3 ANSI Z133.1 Safety Standards

1.01.4 Related ISA Best Management Practices (BMP’s)

1.01.5 Design Guidelines:

i) UT-Austin will not approve designs proposing additional tree plantings within existing tree canopies and CRZ.

ii) There shall be no site improvements located within the CRZ. Site improvements include: light fixtures, signage, paving that require excavating, tables/benches/walls that require footings.

iii) There shall be no plant materials located within CRZ, including turf and groundcovers. Mulch only.

1.02.0 Planting Soil: refer to UT-Austin soil specifications and standards.

1.03.0 Irrigation: Refer to UT-Austin landscape irrigation specifications. Note: Tree irrigation zones (valves) must be separate from other landscape irrigation zones. Every newly planted tree shall have a minimum of 1 irrigation bubbler installed (drip allowed), with the goal of watering as much of the root ball surface area as possible.

1.04.0 Staking: Place 3 t-posts (or similar) around each tree, and drive into existing soils. Wire, rope, or other methods of securing the tree shall not injure the bark. Stakes should be removed after the first growing season. Posts must be marked for safety (painting, caps, etc.). Six foot t-posts are the typical means of staking.

1.05.0 Tree Grates: Only in instances of pier and beam (floating-deck) walk areas will tree grates be permitted. These are areas where a significant gap exists between top of root ball of newly planted trees and the finished elevation of the hardscape. No tree grates shall be installed on existing mature trees.

1.06.0 Types of Nursery Stock: Trees and shrubs can be purchased as bare root, in containers or pots, or with root balls wrapped in burlap (B&B). Bare root trees and shrubs are usually less expensive than containerized or B&B plants, but are available only during their dormant season, usually in early spring. Containerized and B&B trees and shrubs are available throughout the growing season. The preference is for all plant material to be from local seed source. UT-landscape services shall receive at least 48 hour notice of delivery of plants to job site.

1.06.1 Planting of Bare Root Trees
1.06.11 Roots of bare root trees should be moist and protected at all times prior to planting. Prepare planting hole for each plant before removing it from their protected area.

1.06.12 The hole prepared shall be large enough to spread the roots without crowding. The sides of the hole shall be roughed sure to ensure glazing of hole does not occur.

1.06.13 Inspect roots and prune any that appear broken or damaged.

1.06.14 Place the roots in the hole at a level so that the soil surface will be at the same level where the plant was previously growing, as indicated by the slightly darker area of the trunk. Trees should be planted so that trunk flare is visible above the final soil surface.

1.06.15 Backfill with existing soil from excavated hole, and add the soil into the hole a few inches at a time, firming the soil after each addition. While backfilling, be sure the plant remains vertical and be careful not to damage roots. Use water to settle the soil around the roots while backfilling. Do not compact wet soil.

1.06.16 After backfilling is complete, form a ridge of soil (berm) around the edge of the hole to hold water on the roots.

1.06.17 Thoroughly water the plant at installation. Mulching with a local hardwood mulch helps retain moisture and deter weeds. Mulch root ball with 3” of mulch and keep mulch 1-2 inches away from the plant's trunk to prevent damage from moisture.
1.06.2 Planting of Containerized Trees

1.06.21 Prepare a planting hole as described in #2 above. The depth of the hole should be the same as the soil in the container, and the width of the hole should be at least twice the width of the container.

1.06.22 Once the planting hole is prepared, lay the containerized tree or shrub on its side and gently slide the plant out of the container. It may be necessary to push on the sides of the container to loosen the root ball. If the plant has become root-bound and roots have circled the container, slice the root ball in 4-5 places with a pruning saw or hand pruners that will cleanly cut roots. Loosen exterior of root ball to promote lateral root growth.

1.06.23 Place the intact root ball in the hole. Trees should be planted so that trunk flare is visible above the final soil surface. Ideally, this is the same level at which the tree was growing in the container, but many trees are buried several inches deep.

1.06.24 Backfill the soil into the hole a few inches at a time, firming the soil after each addition. While backfilling, be sure the tree remains vertical.

1.06.25 Form a ridge to hold water and stake and protect trees as described above under "Planting Bare Root Trees and Shrubs."

Diagram 2

1.06.3 Planting of Balled and Burlapped Trees (B&B)
1.06.31 Prepare a planting hole as described above. The depth of the hole should be the same as the soil in the root ball, and the width of the hole should be at least twice the width of the root ball.

1.06.32 Place the root ball into the hole so that the soil surface will be at the same level where the plant was previously growing, as indicated by the slightly darker area of the trunk. This is usually the same level as the soil in the root ball. Trees should be planted so that trunk flare is visible above the final soil surface.

1.06.33 Cut the twine from the root ball and peel back the burlap and any metal basket or other material meant to hold the root ball together. Remove burlap from at least top third of root ball. Remove all metal from root ball. Also be sure to remove all twine from around the trunk of the tree or shrub.

1.06.34 Backfill the soil into the hole a few inches at a time, firming the soil after each addition. While backfilling, be sure the tree remains vertical.

1.06.35 Form a ridge to hold water and stake trees as illustrated.

1.07.0 Install a tree guard on the base of each new tree to protect from weed trimmer damage. The guard must be expandable as the tree grows.
Appropriate B&B Root Ball Sizes
Trunk Caliper (inches)    Root ball Diameter
½ --------------------------- 12
¾ --------------------------- 14
1 --------------------------- 16
½ --------------------------- 20
2 --------------------------- 24
2 ½ ------------------------- 28
3 --------------------------- 32

Common Planting Problems
    Planting too deep – roots suffocate
    Planting too shallow – roots dry out
    Hole too narrow – root system struggles to establish
    Soft fill added to bottom of hole – plant settles too deeply
    Twine left on trunk – girdles trunk
    Wire basket left intact – girdles roots
    Container tree circling roots left intact – root system struggles to establish/girdles trunk
Examples of tree planting details for construction documents:

- Central leader. (See crown observations detail).
- Trunk caliper shall meet ANSI Z60 current edition for root ball size.
- Root ball modified as required.
- Round-topped soil berm 4" high x 6" wide above root ball surface shall be constructed around the root ball. Berm shall begin at root ball periphery.
- Existing soil slope sides of loosened soil.
- Bottom of root ball rests on existing or recompacted soil.
- Top of root ball shall be flush with finished grade.
- Prior to mulching, lightly tamp soil around the root ball in 4" bays to brace tree. Do not over compact. When the planting hole has been backfilled, pour water around the root ball to settle the soil.
- Loosened soil. Dig and turn the soil to reduce compaction to the area and depth shown.
- 4" layer of mulch. No more than 1" of mulch on top of root ball. (See specifications for mulch).
- Finished grade.

Notes:
1- Trees shall be of quality prescribed in crown observations and root observations details and specifications.
2- See specifications for further requirements related to this detail.

Design & Construction Standards, April 2016
Notes:
1. Observations of roots shall occur prior to acceptance. Roots and substrate may be removed during the observation process; substrate/soil shall be replaced after observation has been completed.
2. Small roots (3-5 mm) that grow around, up, or down the root ball periphery are considered a normal condition in container production and are acceptable; however they should be eliminated at the time of planting. Roots on the periphery can be removed at the time of planting. (See root ball shaving container detail).
3. Site specifications for observation process and requirements.

ROOT OBSERVATIONS DETAIL - CONTAINER
Remove nursery stake. If central leader needs to be straightened or held erect, it is acceptable to attach a 3/8" x 8' hemp rope pole to the central leader and trunk.

32" long non-abrasive rubber ties.

Two (2) three inch lodge pole pine stakes. Install approximately 2" away from the edge of the root ball. Stake location shall not interfere with permanent branches.
2.00.0 Tree Pruning Specifications

2.01.0 Projects on The University of Texas at Austin shall adhere to specifications based on the most current editions of the following for tree pruning:

- 2.01.1 American National Standards Institute (ANSI) A300 - 01 Pruning Standards 2008(R2015)
- 2.01.2 ANSI Z133.1 Safety Standards
- 2.01.3 Related ISA Best Management Practices (BMP's)

2.02.0 Contractors will apply the standards and guidelines when engaged in pruning operations on campus. To ensure that pruning is appropriate for the species and tree/site conditions, it is important to have a clear understanding of the specific needs of the tree and the objectives for pruning. Pruning objectives shall comply to section 2.04.0.

2.03.0 Requirements for Pruning Trees

- 2.03.1 No more than 25% of the tree may be pruned. Anything above 25% must be discussed and approved by UT Arborist.
- 2.03.2 No tree shall be cut back in such a manner that its health will be impaired. An exception to this may occur in tree removal or emergency storm damage situations in which protecting people or property is urgent. Any emergency procedures shall be brought to the attention of the UT Arborist.
- 2.03.3 When pruning cuts are made to a lateral branch, the remaining branch must possess a basal thickness of at least half the diameter of the wound affected. Such cuts shall be considered correctly done when the branch collar is left intact and the cut is not “flush” with the stem.
- 2.03.4 Tree branches shall be removed and controlled in such a manner as not to cause damage to other parts of the tree or to other plants and property.
- 2.03.5 All cutting tools and saws used in pruning shall be kept adequately sharpened so as to retain smooth surfaces and secure bark on all cuts.
- 2.03.6 Precautions for the inadvertent transmittal of oak wilt will be recognized. This includes the disinfecting of cutting tools between trees and cuts to be treated with tree wound dressing.

2.04.0 Pruning Objectives

- 2.04.1 Maintenance Pruning: Recommended when the primary objective is to maintain or improve tree health and structure, and includes risk reduction pruning.
- 2.04.2 Risk Reduction Pruning: Recommended when the primary objective is to reduce overall tree risk and chance of limb or tree failure.

2.05.0 Pruning Types

- 2.05.1 Crown Cleaning: The selective removal of one or more of the following items: dead, dying or diseased branches, weak branches and water sprouts.
- 2.05.2 Crown Thinning: The selective removal of branches to increase light penetration, air movement and to reduce weight.
2.05.3 Crown Raising: The removal of lower branches to provide clearance.
2.05.4 Crown Reduction or Shaping: Decrease the height and/or spread of a tree. Consideration should be given to the ability of the species to sustain this type of pruning.
2.05.5 Vista Pruning: The selective thinning of framework limbs or specific areas of the crown to allow a view of an object from a predetermined spot.
2.05.6 Crown Restoration: Should improve the structure, form and appearance of trees that have been severely headed, vandalized or storm damaged.

2.06.0 Campus Clearance Recommendations
2.06.1 All trees and/or branches in or around infrastructure shall be shortened or removed when necessary to prevent damage to infrastructure or tree.
2.06.2 Growth on the tree should be directed away from infrastructure such as buildings light poles power lines and signs by reducing and/or removing limbs on that area of the tree.
2.06.3 Vertical clearance for roads shall be in accordance with Austin city code Section 6-3-25 and provide a minimum clearance of 14 above street level. An 8’ vertical clearance shall be provided for pedestrian walkways.
2.06.4 Building Clearance: Clear all branches and foliage in contact with or within 2 foot of roofs, walls, stairways, decks or other building appendages to the extent feasible while maintaining aesthetics and canopy structure. Prune to direct growth parallel to or away from the building.
2.06.5 Exceptions will be made in instances that operations will eventually hinder the structural integrity of the tree or clearly cannot conform to ANSI A300 standards.

2.07.0 Prohibited Pruning Acts
2.07.1 Excessive Pruning: Except for clearance of utility lines, traffic or abating a public nuisance, excessive pruning will not be tolerated.
2.07.2 Topping: Topping is the indiscriminate cutting of tree branches to stubs or lateral branches that are not large enough to assume the terminal role. Other names for topping include “heading,” “tipping,” “hat-racking,” and “rounding over.”
2.07.3 “Lion Tailing”: Excessive removal of branches from the lower two-thirds of a stem or branch.
2.07.4 No pruning of a tree’s canopy shall take place to compensate for removal or damage to its root system.
2.07.5 No cavities shall be filled with any substance (except in instances of bee hive relocations)
Natural Target Pruning

Hardwoods

Dead Branch

Branch Bark Ridge

Living Branch

Conifers

Branch Bark Ridge

Cut First

Branch Collar

for Living or Dead Branches
3.00.0 Tree Removal Specifications

3.01.0 Projects on The University of Texas at Austin shall adhere to specifications based on the most recent editions of the following for tree removals:

- 3.01.1 American National Standards Institute (ANSI) A300 – 01 Pruning Standards 2008(R2015)
- 3.01.2 ANSI Z133.1 Safety Standards
- 3.01.3 Related ISA Best Management Practices (BMP’s)

3.02.0 A campus tree shall not be removed without university review and approval. All removals as a result of a development project or campus operations shall follow the specifications in section 5.00 of the The University of Texas at Austin – Tree Preservation and Protection, Standards and Specifications.

Any tree removed for campus operations will likely be dead or a risk to the university. These tree locations will be made available for new trees planted by Landscape Services (Arbor Day, memorial trees, etc.).

3.03.0 Trees may be removed if:

- 3.03.1 A tree is infected with an insect or disease and its removal is recommended practice to prevent transmission.
- 3.03.2 The tree is creating an extreme nuisance because of it species, size, location, or condition. The nuisance could be caused by fruit or seed drop, harboring insects, root conflicts and excessive twig or limb breakage.
- 3.03.3 The tree is posing a severe safety risk that cannot be corrected by pruning, transplanting or other treatments. Tree risk assessments (per the ISA Tree Risk Assessment Qualification ANSI A300-09 Tree Risk Assessment (2011)) should be performed as needed for significant trees.
- 3.03.4 The tree severely interferes with growth and development of a more desirable tree.
- 3.03.5 The tree’s aesthetic value is so low that the site would be enhanced visually by the removal of the tree.
- 3.03.6 Any construction, improvements or maintenance to be made around the tree would substantially interfere with the tree’s natural growth and size or would damage or destroy it.
- 3.03.7 The tree has been topped or disfigured thus producing an unsound branching structure conducive to severe storm damage, wind throw and accelerated death.
4.00.0 Plant Healthcare (PHC) for Trees

4.01.0 A Soil Analysis shall be done when prescribing soil amendments and fertilizer for trees.
4.02.0 The application of pesticides shall be done by a Texas Department of Agriculture (TDA) licensed applicator, and the products must be labeled to target the desired pest. All applications shall be logged and recorded per TDA rules. All pesticide recommendations must come from an ISA certified arborist.
4.03.0 Tree Growth Regulators (TGR) must be applied by a TDA licensed applicator, and be used only as the label states. Special considerations are for trees in overhead utility corridors or smaller grower spaces, and trees growing in reduced soil volumes.
4.04.0 Soil Health is critical to the survival of trees at UT-Austin. Several tactics are used to improve the soils where trees grow. These include incorporating various types of compost and other forms of organic matter (via soil injection or air-tillage), such as bio-char, mycorrhiza fungi, and humate. Fertilizers and fungicides are used only as a last resort where timing and condition of the tree are of utmost importance.
This document contains information which will help to standardize the life cycle evaluation process. Use of the values and schedules contained within this document will allow the University to compare the results of analysis for multiple projects to determine best practice trends.

Note: The University reserves the right to modify these operational schedules and values on a case by case basis. Obtain verification from the UT Project Manager that these schedules will be acceptable prior to commencement of analysis.

**Classroom Buildings**

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Miscellaneous Loads: ........................................0.5 watts per square foot
Occupant Density (Small Class): 15 square foot per person
Occupant Density (Lecture Hall): 6 square foot per person
Space Sensible Heat Gain from Occupants: 250 btu per hour
Space Latent Heat Gain from Occupants: 200 btu per hour

**Dormitories**

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Miscellaneous Loads: 2.5 watts per square foot
Occupant Density: 100 square foot per person
Space Sensible Heat Gain from Occupants: 250 btu per hour
Space Latent Heat Gain from Occupants: 200 btu per hour
### Laboratories

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Miscellaneous Loads: ....................................5.0 watts per square foot
Occupant Density:..........................................40 square foot per person
Space Sensible Heat Gain from Occupants: ..250 btu per hour
Space Latent Heat Gain from Occupants:......200 btu per hour
6.01.10 – APPENDIX: SUPPLEMENTAL MATERIAL FOR SECTION 4.02
DESIGN AND CONSTRUCTION STANDARD

Office Buildings

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Miscellaneous Loads: ........................................1.5 watts per square foot
Occupant Density:..............................................110 square foot per person
Space Sensible Heat Gain from Occupants: ..245 btu per hour
Space Latent Heat Gain from Occupants:......155 btu per hour

END OF STANDARD
The latest version of the Building Life-Cycle Cost (BLCC) program can be downloaded for free from http://www1.eere.energy.gov/femp/information/download_blcc.html. BLCC is a program developed by the National Institute of Standards and Technology (NIST) to provide computational support for the analysis of capital investments in buildings.

The following parameters should be utilized to build the LCC model:
Upon opening the BLCC program, create a new Federal Analysis, Financed Project

Project Level Entries

General Information Tab
- Location: Texas
- Utilize End-of-Year Discounting Convention
- Utilize Current Dollar Analysis
- Set Nominal Discount Rate to 6.0%

Key Dates Tab
- Set Base Date
- Length of Study Period shall be 25 years.

Add Alternative Tab
- Create Baseline and add as many other alternatives as will be studied

Alternative Level Entries

General Information Tab
- Enter a brief description of the alternative in the comment box

Contract Costs – Annually Recurring Subfolder
- Cost Type: Debt Service
- Click Create Cost button
- Calculate annual simple mortgage payment for estimated construction cost based on 25 year term and 6.0% interest. Enter this value in the Amount box.
- Change escalation rate to 0.0% (payments will be locked for length of term).

Energy Costs Subfolder:
- Cost Name: pull down Natural Gas and click Create Cost
  *Note: all energy costs will be built from “natural gas” because it is the only utility imported to the campus. UT generates its own electricity, steam, and chilled water locally.
- Name: Electricity
- Annual Consumption: enter value from energy model. Change units to kWh.
- Click Energy Cost tab
  - Change Rate Schedule to Industrial
  - Enter Price/kWh: $0.0770
  - Retain DOE Price Escalation Rates are for Natural Gas (do not override)

Go back to Energy Costs Subfolder to create new cost:
6.01.20 – APPENDIX: SUPPLEMENTAL MATERIAL FOR SECTION 4.02 – LCC Input Guide
DESIGN AND CONSTRUCTION STANDARD

- Cost Name: pull down Natural Gas and click Create Cost
- Name: Chilled Water
- Annual Consumption: enter value from energy model. Change units to Therm.
- Click Energy Cost tab
  - Change Rate Schedule to Industrial
  - Enter Price/Therm: $0.8875
  - Retain DOE Price Escalation Rates are for Natural Gas (do not override)

Go back to Energy Costs Subfolder to create new cost:
- Cost Name: pull down Natural Gas and click Create Cost
- Name: Steam
- Annual Consumption: enter value from energy model. Change units to Therm.
- Click Energy Cost tab
  - Change Rate Schedule to Industrial
  - Enter Price/Therm: $0.9140
  - Retain DOE Price Escalation Rates are for Natural Gas (do not override)

Water Costs Subfolder:
- Cost Name: Water and click Create Cost
- Units: 1,000 Gallons
- Annual Water Usage: enter calculated values
- Price/Unit: $2.77 for usage; $4.49 for disposal (there is no seasonal difference, so usage and price values can simply be entered on one line).
- Price Escalation Rates tab
  - Usage and Disposal Cost Escalation: 3.00%

Capital Component Subfolder:
- OM&R Costs – Annually Recurring Subfolder
  - Cost Name: User Defined and click Create Cost
    - Amount: enter calculated value
    - Annual Rate of Increase: 3.00%
- OM&R Costs – Non-Annually Recurring Subfolder (if needed)
  - Cost Name: User Defined and click Create Cost
    - Years/Months (from Base Date): enter value
    - Amount: enter calculated value
    - Annual Rate of Increase: 3.00%

END OF STANDARD
### Project Level Entries

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(Add as many alternates as are needed)

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### Chilled Water Costs

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### Non-Annually Recurring O&M and Repair Cost

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### OM&R Replacement Cost

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### Chilled Water Costs

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### O&M and Repair Cost

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6.01.21 - APPENDIX: SUPPLEMENTAL MATERIAL FOR SECTION 4.02 - LCC Template Report Forms
DESIGN AND CONSTRUCTION STANDARD
Project Level Entries

General Information
Project Name: Garrison Hall
Location: Austin, Tx
Analyst Name: Travis Alexander
Discounting Convention: End-of-Year
Discount Rate: 6%

Key Dates
Base Date: 1-Jan-08
Length of Study Period: 25 Years

Life-Cycle Analysis Description:
This LCC was performed to determine which type of HVAC system would best support a new student building on campus.

Summary of Results:
The results of this LCC showed that Scenario D is the University's best option when building a new classroom/offices building; however due to University's need to limit electrical demand, Scenario C is recommended.

(Add as many alternates as are needed)
Alternate Name: Scenario A
Alternate Description:
This alternate explored the use of separate hot and cold deck AHUs with dual duct and mixing laterals. Base on the old UT standard.
### Alternative Level Entries

| Alternate Name: | Scenario A |

### OM&R Replacement Cost

| Cost Name: | Contract Cost |
| Calculated Annual Simple: | $215,279 |
| Cost Name: | OM&R Cost |
| Calculated Annual Simple: | $19,002 |

### Electricity Costs

| Annual Consumption: | 61,000 |
| Units: | Watt-Hour |
| Price/Unit: | $0.077 |

### Chilled Water Costs

| Annual Consumption: | 33,885 |
| Units: | Therm |
| Price/Unit: | $0.8875 |

### Steam Costs

| Annual Consumption: | 2,100 |
| Units: | Therm |
| Price/Unit: | $0.914 |

### Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |
### Alternative Level Entries

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### OM&R Replacement Cost

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### Electricity Costs

| Annual Consumption: | 65,000 |
| Units: | Watt-Hour |
| Price/Unit: | $0.077 |

### Chilled Water Costs

| Annual Consumption: | 31,567 |
| Units: | Therms |
| Price/Unit: | $0.8875 |

### Steam Costs

| Annual Consumption: | 3,570 |
| Units: | Therms |
| Price/Unit: | $0.914 |

### Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |
### Alternative Level Entries

**Alternate Name:** Scenario C

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### Non-Annually Recurring O&M and Repair Cost

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<td>N/A</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>Scenario D</th>
</tr>
</thead>
</table>

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Contract Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple:</td>
<td>$168,142</td>
</tr>
<tr>
<td>Cost Name:</td>
<td>OM&amp;R Cost</td>
</tr>
<tr>
<td>Calculated Annual Simple:</td>
<td>$20,173</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>158,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Watt-Hour</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>34,103</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therms</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Scenario B
**Alternate Description:**
This alternate explored the use of combined hot and cold deck AHUs with dual duct and mixing laterals. Based on the old UT standard.

### Scenario C
**Alternate Description:**
This alternate explored the use of a cooling only AHU, single duct VAV fan powered box with hot water reheat. Based on the industry standard.

### Scenario D
**Alternate Description:**
This alternate explored the use of a cooling only AHU, single duct VAV fan powered box with electric preheat and electric reheat. Based on the industry standard.
NIST BLCC 5.3-07: Detailed LCC Analysis
Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

General Information
File Name: C:\Program Files\BLCC5\projects\Garrison Hall real.xml
Date of Study: Wed Jan 23 09:25:23 CST 2008
Analysis Type: FEMP Analysis, Energy Project
Project Name: Garrison Hall LCC
Project Location: Texas
Analyst: Travis Alexander
Base Date: January 1, 2008
Service Date: January 1, 2008
Study Period: 25 years 0 months (January 1, 2008 through December 31, 2032)
Discount Rate: 6%
Discounting Convention: End-of-Year

Discount and Escalation Rates are NOMINAL (inclusive of general inflation)

Alternative: Scenario A
Initial Cost Data (not Discounted)
Initial Capital Costs
(adjusted for price escalation)
Initial Capital Costs for All Components: $0

Component: Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>61,000.0 kWh</td>
<td>$0.07700</td>
<td>$4,697</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water
(base-year dollars)
<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>33,885.0</td>
<td>Therm $0.88750</td>
<td>$30,073</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam  
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>2,100.0</td>
<td>Therm $0.91400</td>
<td>$1,919</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

- Energy Consumption Costs: $469,008 $36,689
- Energy Demand Charges: $0 $0
- Energy Utility Rebates: $0 $0

Subtotal (for Energy): $469,008 $36,689

Water Usage Costs: $0 $0
Water Disposal Costs: $0 $0

Operating, Maintenance & Repair Costs

- Component:
  - Annually Recurring Costs: $3,086,406 $241,442
  - Non-Annually Recurring Costs: $0 $0

Subtotal (for OM&R): $3,086,406 $241,442

Replacements to Capital Components

- Component: $0 $0

Subtotal (for Replacements): $0 $0
Residual Value of Original Capital Components

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Residual Value of Capital Replacements

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Total Life-Cycle Cost $3,555,413 $278,132

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual CO2</th>
<th>Life-Cycle CO2</th>
<th>Annual SO2</th>
<th>Life-Cycle SO2</th>
<th>Annual NOx</th>
<th>Life-Cycle NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>10,993.48 kg</td>
<td>274,829.40 kg</td>
<td>88.72 kg</td>
<td>2,217.96 kg</td>
<td>12.96 kg</td>
<td>323.91 kg</td>
</tr>
<tr>
<td>SO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chilled Water:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>178,972.96 kg</td>
<td>4,474,201.41 kg</td>
<td>1,444.37 kg</td>
<td>36,108.22 kg</td>
<td>210.93 kg</td>
<td>5,273.23 kg</td>
</tr>
<tr>
<td>SO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>11,091.73 kg</td>
<td>277,285.61 kg</td>
<td>89.51 kg</td>
<td>2,237.78 kg</td>
<td>13.07 kg</td>
<td>326.80 kg</td>
</tr>
<tr>
<td>SO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>201,058.16 kg</td>
<td>5,026,316.42 kg</td>
<td>1,622.60 kg</td>
<td>40,563.96 kg</td>
<td>236.96 kg</td>
<td>5,923.94 kg</td>
</tr>
<tr>
<td>SO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alternative: Scenario B

Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)

Initial Capital Costs for All Components: $0
Component:
Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>65,000.0 kWh</td>
<td>$0.07700</td>
<td>$5,005</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>31,567.0 Therm</td>
<td>$0.88750</td>
<td>$28,016</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>3,570.0 Therm</td>
<td>$0.91400</td>
<td>$3,263</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$463,822</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
</tr>
</tbody>
</table>

Subtotal (for Energy): $463,822 $36,284

Water Usage Costs

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>
### Water Usage Costs

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

### Operating, Maintenance & Repair Costs

**Component:**

<table>
<thead>
<tr>
<th></th>
<th>Annually Recurring Costs</th>
<th>Non-Annnually Recurring Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$2,895,274</td>
<td>$226,490</td>
</tr>
</tbody>
</table>

**Subtotal (for OM&R):**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,895,274</td>
<td>$226,490</td>
<td></td>
</tr>
</tbody>
</table>

### Replacements to Capital Components

**Component:**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Subtotal (for Replacements):**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>

### Residual Value of Original Capital Components

**Component:**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Subtotal (for Residual Value):**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>

### Residual Value of Capital Replacements

**Component:**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Subtotal (for Residual Value):**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>

### Total Life-Cycle Cost

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$3,359,096</td>
<td>$262,774</td>
</tr>
</tbody>
</table>

### Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>11,714.36 kg</td>
<td>292,851.00 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>94.54 kg</td>
<td>2,363.40 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>13.81 kg</td>
<td>345.15 kg</td>
</tr>
<tr>
<td>Chilled Water:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>166,729.80 kg</td>
<td>4,168,130.91 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,345.56 kg</td>
<td>33,638.13 kg</td>
</tr>
<tr>
<td>NOx</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Steam:

- **CO2**: 18,855.94 kg, 471,385.54 kg
- **SO2**: 152.17 kg, 3,804.23 kg
- **NOx**: 22.22 kg, 555.57 kg

**Total:**

- **CO2**: 197,300.10 kg, 4,932,367.45 kg
- **SO2**: 1,592.27 kg, 39,805.76 kg
- **NOx**: 232.54 kg, 5,813.22 kg

**Alternative: Scenario C**

**Initial Cost Data (not Discounted)**

**Initial Capital Costs**
(adjusted for price escalation)

Initial Capital Costs for All Components: $0

**Component:**

**Cost-Phasing**

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

**Energy Costs: Electricity**
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Usage</th>
<th>Price/Unit</th>
<th>Average Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>82,000.0 kWh</td>
<td>$0.07700</td>
<td>$6,314</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Chilled Water**
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Usage</th>
<th>Price/Unit</th>
<th>Average Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>34,103.0 Therm</td>
<td>$0.88750</td>
<td>$30,266</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Steam**
(base-year dollars)
<table>
<thead>
<tr>
<th>Component</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual Usage &amp; Price/Unit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Usage</td>
<td>820.0 kWh</td>
<td>$0.91400</td>
</tr>
<tr>
<td><strong>Life-Cycle Cost Analysis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Initial Capital Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Energy Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$477,196</td>
<td>$37,330</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Energy):</strong></td>
<td>$477,196</td>
<td>$37,330</td>
</tr>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Operating, Maintenance &amp; Repair Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually Recurring Costs</td>
<td>$2,870,232</td>
<td>$224,531</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for OM&amp;R):</strong></td>
<td>$2,870,232</td>
<td>$224,531</td>
</tr>
<tr>
<td><strong>Replacements to Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Replacements):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Original Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Capital Replacements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>
Subtotal (for Residual Value): $0 $0

Total Life-Cycle Cost $3,347,428 $261,861

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>14,778.12 kg</td>
<td>369,442.80 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>119.26 kg</td>
<td>2,981.52 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>17.42 kg</td>
<td>435.42 kg</td>
</tr>
<tr>
<td>Chilled Water:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>180,124.38 kg</td>
<td>4,502,986.29 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,453.66 kg</td>
<td>36,340.52 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>212.29 kg</td>
<td>5,307.16 kg</td>
</tr>
<tr>
<td>Steam:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>147.78 kg</td>
<td>3,694.43 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1.19 kg</td>
<td>29.82 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>0.17 kg</td>
<td>4.35 kg</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>195,050.28 kg</td>
<td>4,876,123.52 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,574.12 kg</td>
<td>39,351.86 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>229.88 kg</td>
<td>5,746.93 kg</td>
</tr>
</tbody>
</table>

Alternative: Scenario D

Initial Cost Data (not Discounted)

Initial Capital Costs (adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component:
Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0
Energy Costs: Electricity
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>$0.07700</td>
<td>$12,166</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>$0.88750</td>
<td>$30,266</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

- Energy Consumption Costs: $542,423 $42,432
- Energy Demand Charges: $0 $0
- Energy Utility Rebates: $0 $0

Subtotal (for Energy): $542,423 $42,432

Water Usage Costs: $0 $0
Water Disposal Costs: $0 $0

Operating, Maintenance & Repair Costs

Component:
- Annually Recurring Costs: $2,504,369 $195,911
- Non-Annually Recurring Costs: $0 $0

Subtotal (for OM&R): $2,504,369 $195,911

Replacements to Capital Components

Component: $0 $0
Subtotal (for Replacements): $0  $0

Residual Value of Original Capital Components
Component: $0  $0

Subtotal (for Residual Value): $0  $0

Residual Value of Capital Replacements
Component: $0  $0

Subtotal (for Residual Value): $0  $0

Total Life-Cycle Cost $3,046,792  $238,343

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>28,474.91 kg</td>
<td>711,853.20 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>229.80 kg</td>
<td>5,744.88 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>33.56 kg</td>
<td>838.98 kg</td>
</tr>
<tr>
<td>Chilled Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>180,124.38 kg</td>
<td>4,502,986.29 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,453.66 kg</td>
<td>36,340.52 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>212.29 kg</td>
<td>5,307.16 kg</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>208,599.29 kg</td>
<td>5,214,839.49 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,683.46 kg</td>
<td>42,085.40 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>245.85 kg</td>
<td>6,146.14 kg</td>
</tr>
</tbody>
</table>
**Project Level Entries**

**General Information**

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Garrison Hall Variation - Dorm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Texas</td>
</tr>
<tr>
<td>Analyst Name:</td>
<td>Travis Alexander</td>
</tr>
<tr>
<td>Discounting Convention</td>
<td>End-of-Year</td>
</tr>
<tr>
<td>Discount Rate:</td>
<td>6%</td>
</tr>
</tbody>
</table>

**Key Dates**

<table>
<thead>
<tr>
<th>Base Date:</th>
<th>1-Jan-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Study Period</td>
<td>25 Years</td>
</tr>
</tbody>
</table>

**Life-Cycle Analysis Description:**

This LCC was performed to determine which type of HVAC system would best support a new dorm on campus.

**Summary of Results:**

After reviewing the results from the three LCC performed, the FP VAV scenario proved to have the lowest life cycle cost. Considerations for individual occupant control may require a closer look at individual fan coil option based project needs.

**Alternate Name:** FP VAV

**Alternate Description:**

This alternate explored the use of a single duct, variable air volume, central air-handling units with parallel fan powered VAV boxes with hot water reheat coils, zoned for individual living suite control. In this alternate building ventilation would be provided by dedicated outside air pre-treatment units.
### Alternative Level Entries

| Alternate Name: | FP VAV |

### OM&R Replacement Cost

| Cost Name: | Capital Cost |
| Calculated Annual Simple: | $168,445 |
| Cost Name: | Maintenance |
| Calculated Annual Simple: | $21,255 |

### Electricity Costs

| Annual Consumption: | 204,000 |
| Units: | kWh |
| Price/Unit: | $0.077 |

### Chilled Water Costs

| Annual Consumption: | 45,453 |
| Units: | Therm |
| Price/Unit: | $0.8875 |

### Steam Costs

| Annual Consumption: | 350 |
| Units: | Therm |
| Price/Unit: | $0.914 |

### Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |
### Alternative Level Entries

| Alternate Name | Dual Duct |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name</th>
<th>Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple</td>
<td>$180,301</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Name</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple</td>
<td>$17,327</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>193,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>kWh</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>45,100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

<table>
<thead>
<tr>
<th>Alternate Name</th>
<th>Fan Coil</th>
</tr>
</thead>
</table>

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name</th>
<th>Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple</td>
<td>$211,396</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Name</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple</td>
<td>$21,969</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>157,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>kWh</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>30,969</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>1,060</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase</td>
<td>N/A</td>
</tr>
<tr>
<td>Alternate Name:</td>
<td>Dual Duct</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Alternate Description:</td>
<td>The alternate explored the use of dual duct, variable air volume terminal units. In this alternate building ventilation would be provided by dedicated outside air pre-treatment units.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>Fan Coil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td>This alternate explored the use of individual four-pipe fan coil units for each dorm room or suite may. In this alternate building ventilation would be provided by dedicated outside air pre-treatment units.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>
NIST BLCC 5.3-07: Detailed LCC Analysis
Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

General Information
File Name: C:\Program Files\BLCC5\projects\Dorm-Garrison Variation.xml
Date of Study: Wed Jan 23 09:24:02 CST 2008
Analysis Type: FEMP Analysis, Energy Project
Project Name: Dorm - Garrison Variation
Project Location: Texas
Analyst: Travis Alexander
Base Date: April 1, 2007
Service Date: April 1, 2007
Study Period: 25 years 0 months (April 1, 2007 through March 31, 2032)
Discount Rate: 6%
Discounting Convention: End-of-Year

Discount and Escalation Rates are NOMINAL (inclusive of general inflation)

Alternative: FP VAV

Initial Cost Data (not Discounted)
Initial Capital Costs
(adjusted for price escalation)
Initial Capital Costs for All Components: $0

Component:
Cost-Phasing
Date Portion Yearly Cost
April 1, 2007 100% $0

Total (for Component) $0

Energy Costs: Electricity
(base-year dollars)
Average Price/Unit Annual Cost Annual Demand Annual Rebate
Annual Usage $0.07700 $15,708 $0
204,000.0 kWh

Energy Costs: Chilled Water
(base-year dollars)
Average Annual Usage Price/Unit Annual Cost Annual Demand Annual Rebate

45,453.0 Therm $0.88750 $40,340 $0 $0

Energy Costs: Steam
(base-year dollars)

Average Annual Usage Price/Unit Annual Cost Annual Demand Annual Rebate

350.0 Therm $0.91400 $320 $0 $0

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

- Energy Consumption Costs: $718,659 $56,219
- Energy Demand Charges: $0 $0
- Energy Utility Rebates: $0 $0

Subtotal (for Energy): $718,659 $56,219

Water Usage Costs: $0 $0

Water Disposal Costs: $0 $0

Operating, Maintenance & Repair Costs

Component:
- Annually Recurring Costs: $2,527,269 $197,702
- Non-Annually Recurring Costs: $0 $0

Subtotal (for OM&R): $2,527,269 $197,702

Replacements to Capital Components

Component:
- $0 $0

Subtotal (for Replacements): $0 $0
Residual Value of Original Capital Components

<table>
<thead>
<tr>
<th>Component</th>
<th>$0</th>
<th>$0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtotal (for Residual Value):</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Residual Value of Capital Replacements

<table>
<thead>
<tr>
<th>Component</th>
<th>$0</th>
<th>$0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtotal (for Residual Value):</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total Life-Cycle Cost

$3,245,928 $253,921

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>36,765.07 kg</td>
<td>919,101.60 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>296.71 kg</td>
<td>7,417.44 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>43.33 kg</td>
<td>1,083.24 kg</td>
</tr>
<tr>
<td>Chilled Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>240,072.53 kg</td>
<td>6,001,649.01 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,937.46 kg</td>
<td>48,435.20 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>282.95 kg</td>
<td>7,073.46 kg</td>
</tr>
<tr>
<td>Steam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>1,848.62 kg</td>
<td>46,214.27 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>14.92 kg</td>
<td>372.96 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>2.18 kg</td>
<td>54.47 kg</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>278,686.23 kg</td>
<td>6,966,964.87 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>2,249.09 kg</td>
<td>56,225.61 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>328.46 kg</td>
<td>8,211.17 kg</td>
</tr>
</tbody>
</table>

Alternative: Dual Duct

Initial Cost Data (not Discounted)

Initial Capital Costs
Initial Capital Costs for All Components: $0

Component: Copy of:
Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1, 2007</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>193,000.0 kWh</td>
<td>$0.07700</td>
<td>$14,861</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>45,100.0 Therm</td>
<td>$0.88750</td>
<td>$40,026</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>300.0 Therm</td>
<td>$0.91400</td>
<td>$274</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

<table>
<thead>
<tr>
<th>Costs</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$703,282</td>
<td>$55,016</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>


Subtotal (for Energy): $703,282 $55,016

Water Usage Costs $0 $0
Water Disposal Costs $0 $0

**Operating, Maintenance & Repair Costs**

Component: Copy of:

- Annually Recurring Costs $2,609,771 $204,156
- Non-Annually Recurring Costs $0 $0

Subtotal (for OM&R): $2,609,771 $204,156

**Replacements to Capital Components**

Component: Copy of: $0 $0

Subtotal (for Replacements): $0 $0

**Residual Value of Original Capital Components**

Component: Copy of: $0 $0

Subtotal (for Residual Value): $0 $0

**Residual Value of Capital Replacements**

Component: Copy of: $0 $0

Subtotal (for Residual Value): $0 $0

**Total Life-Cycle Cost** $3,313,053 $259,172

**Emissions Summary**

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>34,782.64 kg</td>
<td>869,542.20 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>280.71 kg</td>
<td>7,017.48 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>40.99 kg</td>
<td>1,024.83 kg</td>
</tr>
</tbody>
</table>
### Chilled Water:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th></th>
<th></th>
<th>SO2</th>
<th></th>
<th></th>
<th>NOx</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>238,207.86 kg</td>
<td>5,955,033.33 kg</td>
<td></td>
<td>1,922.41 kg</td>
<td>48,059.00 kg</td>
<td></td>
<td>280.75 kg</td>
<td>7,018.52 kg</td>
</tr>
</tbody>
</table>

### Steam:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th></th>
<th></th>
<th>SO2</th>
<th></th>
<th></th>
<th>NOx</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,584.53 kg</td>
<td>39,612.23 kg</td>
<td></td>
<td>12.79 kg</td>
<td>319.68 kg</td>
<td></td>
<td>1.87 kg</td>
<td>46.69 kg</td>
</tr>
</tbody>
</table>

### Total:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th></th>
<th></th>
<th>SO2</th>
<th></th>
<th></th>
<th>NOx</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>274,575.03 kg</td>
<td>6,864,187.76 kg</td>
<td></td>
<td>2,215.91 kg</td>
<td>55,396.16 kg</td>
<td></td>
<td>323.61 kg</td>
<td>8,090.03 kg</td>
</tr>
</tbody>
</table>

### Alternative: Fan Coil

**Initial Cost Data (not Discounted)**

**Initial Capital Costs**

(adjusted for price escalation)

**Initial Capital Costs for All Components:** $0

### Component: Copy of: Copy of:

**Cost-Phasing**

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1, 2007</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Total (for Component)** $0

### Energy Costs: Electricity

(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Annual Usage</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>157,000.0 kWh</td>
<td>$0.07700</td>
<td>$12,089</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

### Energy Costs: Chilled Water

(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Annual Usage</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30,696.0 Therm</td>
<td>$0.88750</td>
<td>$27,243</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>
### Energy Costs: Steam (base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,060.0 Therm</td>
<td>$0.91400</td>
<td>$969</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

### Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$513,813</td>
<td>$40,194</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Energy):</td>
<td>$513,813</td>
<td>$40,194</td>
</tr>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Operating, Maintenance &amp; Repair Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component: Copy of: Copy of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually Recurring Costs</td>
<td>$3,088,937</td>
<td>$241,640</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for OM&amp;R):</td>
<td>$3,088,937</td>
<td>$241,640</td>
</tr>
<tr>
<td>Replacements to Capital Components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component: Copy of: Copy of:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Replacements):</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Residual Value of Original Capital Components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component: Copy of: Copy of:</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>
Subtotal (for Residual Value): $0  $0

Residual Value of Capital Replacements
Component: Copy of: Copy of: $0  $0

Subtotal (for Residual Value): $0  $0

Total Life-Cycle Cost $3,602,750  $281,835

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>28,294.69 kg</td>
<td>707,347.80 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>228.35 kg</td>
<td>5,708.52 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>33.35 kg</td>
<td>833.67 kg</td>
</tr>
<tr>
<td><strong>Chilled Water:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>162,129.37 kg</td>
<td>4,053,123.40 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,308.44 kg</td>
<td>32,709.99 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>191.08 kg</td>
<td>4,776.95 kg</td>
</tr>
<tr>
<td><strong>Steam:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>5,598.68 kg</td>
<td>139,963.21 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>45.18 kg</td>
<td>1,129.55 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>6.60 kg</td>
<td>164.96 kg</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>196,022.74 kg</td>
<td>4,900,434.41 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,581.97 kg</td>
<td>39,548.05 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>231.03 kg</td>
<td>5,775.58 kg</td>
</tr>
</tbody>
</table>
## Project Level Entries

### General Information

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>New Laboratory Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Texas</td>
</tr>
<tr>
<td>Analyst Name:</td>
<td>Travis Alexander</td>
</tr>
<tr>
<td>Discounting Convention:</td>
<td>End-of-Year</td>
</tr>
<tr>
<td>Discount Rate:</td>
<td>6%</td>
</tr>
</tbody>
</table>

### Key Dates

| Base Date:          | 1-Jan-08                |
| Length of Study Period: | 25 Years              |

### Life-Cycle Analysis Description:

This LCC was performed to determine which type of HVAC system would best support a new laboratory on campus. Results are based on a study for Biomedical Engineering facilities. The study included comparisons of installed costs, maintenance costs and operating costs for two different HVAC systems.

### Summary of Results:

The results of the LCC for a new laboratory building showed that System 2 had the lowest overall costs.

### Alternate Name:  System 1

### Alternate Description:

The system is a constant volume, double-duct configuration with heat wheel type heat recovery units serving lab areas, based on the old UT Austin Standards.
### Alternative Level Entries

| Alternate Name: | System 1 |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Yearly Operational Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple:</td>
<td>$313,398</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Yearly Maintenance Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple:</td>
<td>$11,284</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Installed Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple:</td>
<td>$776,172</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

<table>
<thead>
<tr>
<th>Alternate Name</th>
<th>System 2</th>
</tr>
</thead>
</table>

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name</th>
<th>Calculated Annual Simple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly Operational Costs</td>
<td>$317,649</td>
</tr>
<tr>
<td>Yearly Maintenance Costs</td>
<td>$14,131</td>
</tr>
<tr>
<td>Installed Cost</td>
<td>$664,329</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>Units</th>
<th>Price/Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>Units</th>
<th>Price/Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption</th>
<th>Units</th>
<th>Price/Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage</th>
<th>Units</th>
<th>Price/Unit</th>
<th>Price Escalation Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months</th>
<th>Amount</th>
<th>Annual Rate of Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Alternate Name:</td>
<td>System 2</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Alternate Description:</td>
<td>The system is a single duct variable air volume lab system, similar to the type of system found in corporate research lab.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>
NIST BLCC 5.3-07: Detailed LCC Analysis
Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

General Information
File Name: C:\Program Files\BLCC5\projects\BME Building.xml
Date of Study: Wed Jan 23 09:02:25 CST 2008
Analysis Type: FEMP Analysis, Energy Project
Project Name: Biomedical Engineering Building
Project Location: Texas
Analyst: Travis Alexander
Base Date: January 1, 2008
Service Date: January 1, 2008
Study Period: 25 years 0 months (January 1, 2008 through December 31, 2032)
Discount Rate: 6%
Discounting Convention: End-of-Year

Discount and Escalation Rates are NOMINAL (inclusive of general inflation)

Alternative: System 1
Initial Cost Data (not Discounted)
Initial Capital Costs
(adjusted for price escalation)
Initial Capital Costs for All Components: $0

Component: Cost-Phasing
Date Portion Yearly Cost
January 1, 2008 100% $0

Total (for Component) $0

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

<table>
<thead>
<tr>
<th>Energy Costs</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>
Subtotal (for Energy): $0 $0

Water Usage Costs $0 $0
Water Disposal Costs $0 $0

Operating, Maintenance & Repair Costs

Component:
- Annually Recurring Costs $15,632,536 $1,222,896
- Non-Annually Recurring Costs $0 $0

Subtotal (for OM&R): $15,632,536 $1,222,896

Replacements to Capital Components

Component: $0 $0

Subtotal (for Replacements): $0 $0

Residual Value of Original Capital Components

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Residual Value of Capital Replacements

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Total Life-Cycle Cost $15,632,536 $1,222,896

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>0.00 kg</td>
<td>0.00 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>0.00 kg</td>
<td>0.00 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>0.00 kg</td>
<td>0.00 kg</td>
</tr>
</tbody>
</table>
Alternative: System 2
Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)
Initial Capital Costs for All Components: $0

Component: Copy of:
Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Energy):</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Operating, Maintenance &amp; Repair Costs</td>
<td>$14,327,489</td>
<td>$1,120,806</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for OM&amp;R):</td>
<td>$14,327,489</td>
<td>$1,120,806</td>
</tr>
</tbody>
</table>

Replacements to Capital Components

Component: Copy of: $0 $0
Subtotal (for Replacements): $0  $0

Residual Value of Original Capital Components
Subtotal (for Residual Value): $0  $0

Residual Value of Capital Replacements
Subtotal (for Residual Value): $0  $0

Total Life-Cycle Cost $14,327,489  $1,120,806

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>0.00 kg</td>
<td>0.00 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>0.00 kg</td>
<td>0.00 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>0.00 kg</td>
<td>0.00 kg</td>
</tr>
</tbody>
</table>
# Project Level Entries

## General Information

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Multiple Locations Vs One Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Texas</td>
</tr>
<tr>
<td>Analyst Name:</td>
<td>Travis Alexander</td>
</tr>
<tr>
<td>Discounting Convention:</td>
<td>End-of-Year</td>
</tr>
<tr>
<td>Discount Rate:</td>
<td>6%</td>
</tr>
</tbody>
</table>

## Key Dates

<table>
<thead>
<tr>
<th>Base Date:</th>
<th>1-Jan-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Study Period:</td>
<td>25 Years</td>
</tr>
</tbody>
</table>

## Life-Cycle Analysis Description:

This LCC Analysis was performed to determine whether it is more cost effective to place AHUs in a building on one floor or to have AHUs in different locations. The LCC specifically compared the placement of 4 AHUs on one floor to placing one AHU on each floor based on the four floor Garrison Hall building.

## Summary of Results:

The results of this LCC showed that placing the AHUs in one location is more cost effective then placing AHUs on each floor.

## (Add as many alternates as are needed)

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>One Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
<tr>
<td>The alternate looked at the placing the AHUs in one location in the building.</td>
<td></td>
</tr>
</tbody>
</table>
### Alternative Level Entries

| Alternate Name: | One Location |

### OM&R Replacement Cost

| Cost Name: | Contract Cost |
| Calculated Annual Simple: | $177,295 |

| Cost Name: | OM&R Cost |
| Calculated Annual Simple: | $20,173 |

### Electricity Costs

| Annual Consumption: | 158,000 |
| Units: | Watt-Hour |
| Price/Unit: | $0.077 |

### Chilled Water Costs

| Annual Consumption: | 34,103 |
| Units: | Therms |
| Price/Unit: | $0.8875 |

### Steam Costs

| Annual Consumption: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |

### Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |
### Alternative Level Entries

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>Multiple Locations</th>
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</thead>
</table>

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Contract Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple:</td>
<td>$178,703</td>
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<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>OM&amp;R Cost</th>
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<tbody>
<tr>
<td>Calculated Annual Simple:</td>
<td>$20,173</td>
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</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>158,000</th>
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<tbody>
<tr>
<td>Units:</td>
<td>Watt-Hour</td>
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<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
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</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>34,103</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therms</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
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</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
<tr>
<td>Alternate Name:</td>
<td>Multiple Locations</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
<tr>
<td>The alternate looked at the placing the AHUs in one room on each floor.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
</tr>
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<tbody>
<tr>
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<table>
<thead>
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<tbody>
<tr>
<td>Alternate Description:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
</tr>
</tbody>
</table>
NIST BLCC 5.3-07: Detailed LCC Analysis
Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

General Information
File Name: C:\Program Files\BLCC5\projects\Multiple Locations Vs One Location.xml
Date of Study: Wed Jan 23 09:22:20 CST 2008
Analysis Type: FEMP Analysis, Energy Project
Project Name: Multiple Locations Vs One Location
Project Location: Texas
Analyst: Travis Alexander
Base Date: January 1, 2008
Service Date: January 1, 2008
Study Period: 25 years 0 months (January 1, 2008 through December 31, 2032)
Discount Rate: 6%
Discounting Convention: End-of-Year

Discount and Escalation Rates are NOMINAL (inclusive of general inflation)

Alternative: One Location
Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)
Initial Capital Costs for All Components: $0

Component:
Cost-Phasing
Date Portion Yearly Cost
January 1, 2008 100% $0

Total (for Component) $0

Energy Costs: Electricity
(base-year dollars)
Average Average Average Average
Annual Usage Price/Unit Annual Cost Annual Demand Annual Rebate
158,000.0 kWh $0.07700 $12,166 $0 $0

Energy Costs: Chilled Water
(base-year dollars)
Average Average Average Average
Annual Usage Price/Unit Annual Cost Annual Demand Annual Rebate
34,103.0 Therm $0.88750 $30,266 $0 $0
## Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Energy Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$542,423</td>
<td>$42,432</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Energy):</strong></td>
<td>$542,423</td>
<td>$42,432</td>
</tr>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Operating, Maintenance &amp; Repair Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually Recurring Costs</td>
<td>$2,621,387</td>
<td>$205,065</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for OM&amp;R):</strong></td>
<td>$2,621,387</td>
<td>$205,065</td>
</tr>
<tr>
<td><strong>Replacements to Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Replacements):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Original Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Capital Replacements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total Life-Cycle Cost</strong></td>
<td>$3,163,809</td>
<td>$247,497</td>
</tr>
</tbody>
</table>

## Emissions Summary
Energy Name | Annual | Life-Cycle
---|---|---

**Electricity:**
- CO2: 28,474.91 kg, 711,853.20 kg
- SO2: 229.80 kg, 5,744.88 kg
- NOx: 33.56 kg, 838.98 kg

**Chilled Water:**
- CO2: 180,124.38 kg, 4,502,986.29 kg
- SO2: 1,453.66 kg, 36,340.52 kg
- NOx: 212.29 kg, 5,307.16 kg

**Total:**
- CO2: 208,599.29 kg, 5,214,839.49 kg
- SO2: 1,683.46 kg, 42,085.40 kg
- NOx: 245.85 kg, 6,146.14 kg

**Alternative: Multiple Locations**

**Initial Cost Data (not Discounted)**

**Initial Capital Costs**
(adjusted for price escalation)

Initial Capital Costs for All Components: $0

**Component: Copy of:**

**Cost-Phasing**

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

**Energy Costs: Electricity**
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>158,000.0 kWh</td>
<td>$0.07700</td>
<td>$12,166</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Chilled Water**
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>34,103.0 Therm</td>
<td>$0.88750</td>
<td>$30,266</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Life-Cycle Cost Analysis**

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----</td>
</tr>
</tbody>
</table>

**Energy Costs**

- **Energy Consumption Costs**
  - $542,423  $42,432
- **Energy Demand Charges**
  - $0  $0
- **Energy Utility Rebates**
  - $0  $0

  **Subtotal (for Energy):**
  - $542,423  $42,432

- **Water Usage Costs**
  - $0  $0
- **Water Disposal Costs**
  - $0  $0

**Operating, Maintenance & Repair Costs**

- **Component: Copy of:**
  - **Annually Recurring Costs**
    - $2,639,387  $206,473
  - **Non-Annually Recurring Costs**
    - $0  $0

  **Subtotal (for OM&R):**
  - $2,639,387  $206,473

**Replacements to Capital Components**

- **Component: Copy of:**
  - $0  $0

  **Subtotal (for Replacements):**
  - $0  $0

**Residual Value of Original Capital Components**

- **Component: Copy of:**
  - $0  $0

  **Subtotal (for Residual Value):**
  - $0  $0

**Residual Value of Capital Replacements**

- **Component: Copy of:**
  - $0  $0

  **Subtotal (for Residual Value):**
  - $0  $0

**Total Life-Cycle Cost**

- $3,181,810  $248,905

**Emissions Summary**

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current Year</td>
</tr>
<tr>
<td>----------</td>
<td>--------------</td>
</tr>
<tr>
<td>CO2</td>
<td>28,474.91 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>229.80 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>33.56 kg</td>
</tr>
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</table>

**Chilled Water:**

<table>
<thead>
<tr>
<th></th>
<th>Current Year</th>
<th>Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>180,124.38 kg</td>
<td>4,502,986.29 kg</td>
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<td>SO2</td>
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</tr>
<tr>
<td>NOx</td>
<td>212.29 kg</td>
<td>5,307.16 kg</td>
</tr>
</tbody>
</table>

**Total:**

<table>
<thead>
<tr>
<th></th>
<th>Current Year</th>
<th>Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>208,599.29 kg</td>
<td>5,214,839.49 kg</td>
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<td>SO2</td>
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<td>245.85 kg</td>
<td>6,146.14 kg</td>
</tr>
</tbody>
</table>
### Project Level Entries

#### General Information

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>UT Austin Energy Recovery Study - 8am to 5pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Austin, Tx</td>
</tr>
<tr>
<td>Analyst Name:</td>
<td>Travis Alexander</td>
</tr>
<tr>
<td>Discounting Convention:</td>
<td>End-of-Year</td>
</tr>
<tr>
<td>Discount Rate:</td>
<td>6%</td>
</tr>
</tbody>
</table>

#### Key Dates

<table>
<thead>
<tr>
<th>Base Date:</th>
<th>1-Jan-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Study Period:</td>
<td>25 Years</td>
</tr>
</tbody>
</table>

#### Life-Cycle Analysis Description:

This LCC was performed to determine at what amount of outside air justifies the increase of price for outside air units with energy recovery compared to ones without energy recovery. The input values for the LCC were determined by taking the difference in costs between the two types of units. A positive LCC total means the energy recovery unit is justified. It was assumed that these units ran 8760 hours a year. The analysis looked at outside air units ranging from 1000 CFM to 50,000 CFM.

#### Summary of Results:

For the range of CFM review, the analysis did not yield positive life cycle costs. Exhaust energy recovery is not recommended for facilities with "normal business" hours (Monday to Friday, 8am to 5pm) except where required by code.

(Add as many alternates as are needed)

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>1,000 CFM</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Alternate Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The alternate was used to determine if the increase of price for 1,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

| Alternate Name: | 1,000 CFM |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Capital Cost</th>
<th>Calculated Annual Simple:</th>
<th>-$2,229</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Name:</td>
<td>Maintenance</td>
<td>Calculated Annual Simple:</td>
<td>-$2,000</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>-454</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Watts-Hours</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>434</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
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### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
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</tr>
<tr>
<td>Price/Unit:</td>
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### Water Costs

<table>
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<tr>
<th>Annual Water Usage:</th>
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</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
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</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

| Alternate Name: | 2,000 CFM |

### OM&R Replacement Cost

| Cost Name: | Capital Cost |
| Cost Name: | Maintenance |
| Calculated Annual Simple: | -$2,112 |
| Calculated Annual Simple: | -$2,000 |

### Electricity Costs

| Annual Consumption: | -1,040 |
| Units: | Watts-Hours |
| Price/Unit: | $0.077 |

### Chilled Water Costs

| Annual Consumption: | 758 |
| Units: | Therm |
| Price/Unit: | $0.8875 |

### Steam Costs

| Annual Consumption: | 31 |
| Units: | Therm |
| Price/Unit: | $0.914 |

### Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |
### Alternative Level Entries

| Alternate Name: | 4,000 CFM |

### OM&R Replacement Cost

| Cost Name: Capital Cost | Calculated Annual Simple: -$1,877 |
| Cost Name: Maintenance | Calculated Annual Simple: -$2,000 |

### Electricity Costs

| Annual Consumption: -2,446 | Units: Watts-Hours | Price/Unit: $0.077 |

### Chilled Water Costs

| Annual Consumption: 1,525 | Units: Therm | Price/Unit: $0.8875 |

### Steam Costs

| Annual Consumption: 62 | Units: Therm | Price/Unit: $0.914 |

### Water Costs

| Annual Water Usage: N/A | Units: N/A | Price/Unit: N/A | Price Escalation Rates: N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: N/A | Amount: N/A | Annual Rate of Increase: N/A |
### Alternative Level Entries

| Alternate Name: | 8,000 CFM |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Calculated Annual Simple:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>-$5,222</td>
</tr>
<tr>
<td>Maintenance</td>
<td>-$2,000</td>
</tr>
</tbody>
</table>

### Electricity Costs

| Annual Consumption:     | -3,923                    |
| Units:                  | Watts-Hours               |
| Price/Unit:             | $0.077                    |

### Chilled Water Costs

| Annual Consumption:     | 3,142                     |
| Units:                  | Therm                     |
| Price/Unit:             | $0.8875                   |

### Steam Costs

| Annual Consumption:     | 128                       |
| Units:                  | Therm                     |
| Price/Unit:             | $0.914                    |

### Water Costs

| Annual Water Usage:     | N/A                       |
| Units:                  | N/A                       |
| Price/Unit:             | N/A                       |
| Price Escalation Rates: | N/A                       |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months:           | N/A                       |
| Amount:                 | N/A                       |
| Annual Rate of Increase:| N/A                       |
### Alternative Level Entries

| Alternate Name: | 15,000 CFM |

### OM&R Replacement Cost

| Cost Name: | Capital Cost |
| Calculated Annual Simple: | -$6,923 |
| Cost Name: | Maintenance |
| Calculated Annual Simple: | -$2,000 |

### Electricity Costs

| Annual Consumption: | -6,658 |
| Units: | Watts-Hours |
| Price/Unit: | $0.077 |

### Chilled Water Costs

| Annual Consumption: | 5,877 |
| Units: | Therm |
| Price/Unit: | $0.8875 |

### Steam Costs

| Annual Consumption: | 239 |
| Units: | Therm |
| Price/Unit: | $0.914 |

### Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |
## Alternative Level Entries

| Alternate Name: | 30,000 CFM |

## OM&R Replacement Cost

| Cost Name: | Capital Cost |
| Calulated Annual Simple: | -$11,499 |
| Cost Name: | Maintenance |
| Calulated Annual Simple: | -$2,000 |

## Electricity Costs

| Annual Consumption: | -10,079 |
| Units: | Watts-Hours |
| Price/Unit: | $0.077 |

## Chilled Water Costs

| Annual Consumption: | 11,476 |
| Units: | Therm |
| Price/Unit: | $0.8875 |

## Steam Costs

| Annual Consumption: | 472 |
| Units: | Therm |
| Price/Unit: | $0.914 |

## Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

## Non-Annually Recurring O&M and Repair Cost

| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |
### Alternative Level Entries

| Alternate Name: | 50,000 CFM |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple:</td>
<td>-$21,239</td>
</tr>
<tr>
<td>Cost Name:</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Calculated Annual Simple:</td>
<td>-$2,000</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>-22,169</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Watts-Hours</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>19,219</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>784</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
<tr>
<td>Alternate Name: 2,000 CFM</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td></td>
</tr>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
<tr>
<td>The alternate was used to determine if the increase of price for 2,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name: 4,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
</tr>
<tr>
<td>The alternate was used to determine if the increase of price for 4,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name: 8,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
</tr>
<tr>
<td>The alternate was used to determine if the increase of price for 8,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name: 15,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
</tr>
<tr>
<td>The alternate was used to determine if the increase of price for 15,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name: 30,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
</tr>
<tr>
<td>The alternate was used to determine if the increase of price for 30,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
<tr>
<td>Alternate Name:</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Alternate Description:</td>
</tr>
</tbody>
</table>
NIST BLCC 5.3-07: Detailed LCC Analysis
Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

General Information

File Name: C:\Program Files\BLCC5\projects\UT Austin Energy Recovery Study - 8am to 5pm.xml
Date of Study: Wed Jan 23 09:27:50 CST 2008
Analysis Type: FEMP Analysis, Energy Project
Project Name: UT Austin Energy Recovery Study - 8am to 5pm
Project Location: Texas
Analyst: Travis Alexander
Base Date: January 1, 2008
Service Date: January 1, 2008
Study Period: 25 years 0 months (January 1, 2008 through December 31, 2032)
Discount Rate: 6%
Discounting Convention: End-of-Year

Discount and Escalation Rates are NOMINAL (inclusive of general inflation)

Alternative: 1,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)
Initial Capital Costs for All Components: $0

Component: Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity Savings
(base-year dollars)

Average: Actual Average: Actual Average: Actual
Annual Usage: Price/Unit: Annual Cost: Annual Demand: Annual Rebate
-454.0 kWh: $0.07700: -35: $0: $0

Energy Costs: Chilled Water Saved
(base-year dollars)

Average: Actual Average: Actual Average: Actual
Annual Usage: Price/Unit: Annual Cost: Annual Demand: Annual Rebate
434.3 Therm: $0.88750: $385: $0: $0

Energy Costs: Steam Saved
(base-year dollars)

Average: Actual Average: Actual Average: Actual
Annual Usage: Price/Unit: Annual Cost: Annual Demand: Annual Rebate
17.3 Therm: $0.91400: $16: $0: $0
## Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Capital Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Energy Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$4,682</td>
<td>$366</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Energy):</strong></td>
<td>$4,682</td>
<td>$366</td>
</tr>
<tr>
<td><strong>Water Usage Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Water Disposal Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Operating, Maintenance &amp; Repair Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually Recurring Costs</td>
<td>$63,672</td>
<td>$4,981</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for OM&amp;R):</strong></td>
<td>$63,672</td>
<td>$4,981</td>
</tr>
<tr>
<td><strong>Replacements to Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Replacements):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Original Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Capital Replacements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total Life-Cycle Cost</strong></td>
<td>$58,990</td>
<td>$4,615</td>
</tr>
</tbody>
</table>

## Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>-81.82 kg</td>
<td>-2,045.45 kg</td>
</tr>
</tbody>
</table>
Chilled Water Saved:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>SO2</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saved</td>
<td>2,293.77 kg</td>
<td>18.51 kg</td>
<td>2.70 kg</td>
</tr>
<tr>
<td>Saved</td>
<td>57,342.66 kg</td>
<td>462.77 kg</td>
<td>67.58 kg</td>
</tr>
</tbody>
</table>

Steam Saved:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>SO2</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saved</td>
<td>91.48 kg</td>
<td>0.74 kg</td>
<td>0.11 kg</td>
</tr>
<tr>
<td>Saved</td>
<td>2,286.95 kg</td>
<td>18.46 kg</td>
<td>2.70 kg</td>
</tr>
</tbody>
</table>

Total:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>SO2</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2,303.43 kg</td>
<td>18.59 kg</td>
<td>2.71 kg</td>
</tr>
<tr>
<td>Total</td>
<td>57,584.16 kg</td>
<td>464.72 kg</td>
<td>67.87 kg</td>
</tr>
</tbody>
</table>

Alternative: 2,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs

(adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component: Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity Savings

(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Price/Unit kWh</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1,040.0</td>
<td>$0.07700</td>
<td>-$80</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water Saved

(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Price/Unit Therm</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>757.7</td>
<td>$0.88750</td>
<td>$672</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved

(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Price/Unit Therm</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.3</td>
<td>$0.91400</td>
<td>$29</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>
### Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Energy Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$7,938</td>
<td>$621</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Energy):</strong></td>
<td>$7,938</td>
<td>$621</td>
</tr>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Operating, Maintenance &amp; Repair Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually Recurring Costs</td>
<td>$-62,172</td>
<td>$-4,864</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for OM&amp;R):</strong></td>
<td>$-62,172</td>
<td>$-4,864</td>
</tr>
<tr>
<td><strong>Replacements to Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Replacements):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Original Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Capital Replacements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total Life-Cycle Cost</strong></td>
<td>$-54,235</td>
<td>$-4,243</td>
</tr>
</tbody>
</table>

### Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-187.43 kg</td>
<td>-4,685.62 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-1.51 kg</td>
<td>-37.81 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-0.22 kg</td>
<td>-5.52 kg</td>
</tr>
</tbody>
</table>
Chilled Water Saved:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>SO2</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4,001.90 kg</td>
<td>32.30 kg</td>
<td>4.72 kg</td>
</tr>
<tr>
<td>Total</td>
<td>100,044.65 kg</td>
<td>807.39 kg</td>
<td>117.91 kg</td>
</tr>
</tbody>
</table>

Steam Saved:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>SO2</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>165.16 kg</td>
<td>1.33 kg</td>
<td>0.19 kg</td>
</tr>
<tr>
<td>Total</td>
<td>4,128.91 kg</td>
<td>33.32 kg</td>
<td>4.87 kg</td>
</tr>
</tbody>
</table>

Total:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>SO2</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3,979.63 kg</td>
<td>32.12 kg</td>
<td>4.69 kg</td>
</tr>
<tr>
<td></td>
<td>99,487.95 kg</td>
<td>802.90 kg</td>
<td>117.26 kg</td>
</tr>
</tbody>
</table>

Alternative: 4,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component:

<table>
<thead>
<tr>
<th>Cost-Phasing</th>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity Savings
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2,446.0 kWh</td>
<td>$0.07700</td>
<td>-$188</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,524.6 Therm</td>
<td>$0.88750</td>
<td>$1,353</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.0 Therm</td>
<td>$0.91400</td>
<td>$57</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
</table>
**Present Value**

<table>
<thead>
<tr>
<th></th>
<th>Annual Value</th>
<th>Life-Cycle Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Capital Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Energy Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$15,614</td>
<td>$1,221</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Energy):</td>
<td>$15,614</td>
<td>$1,221</td>
</tr>
<tr>
<td><strong>Water Usage Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Water Disposal Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Operating, Maintenance &amp; Repair Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually Recurring Costs</td>
<td>$-59,172</td>
<td>$-54,629</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for OM&amp;R):</td>
<td>$-59,172</td>
<td>$-54,629</td>
</tr>
<tr>
<td><strong>Replacements to Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Replacements):</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Original Capital Components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Residual Value):</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Residual Value of Capital Replacements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Residual Value):</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total Life-Cycle Cost</strong></td>
<td>$-43,558</td>
<td>$-3,407</td>
</tr>
</tbody>
</table>

**Emissions Summary**

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual Savings</th>
<th>Life-Cycle Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity Savings:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-440.82 kg</td>
<td>-11,020.21 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-3.56 kg</td>
<td>-88.94 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-0.52 kg</td>
<td>-12.99 kg</td>
</tr>
<tr>
<td><strong>Chilled Water Saved:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### CO2
- Initial: 8,052.59 kg
- Final: 201,309.35 kg

### SO2
- Initial: 64.99 kg
- Final: 1,624.63 kg

### NOx
- Initial: 9.49 kg
- Final: 237.26 kg

### Steam Saved:
- CO2: 327.73 kg
- SO2: 2.64 kg
- NOx: 0.39 kg

### Total:
- CO2: 7,939.51 kg
- SO2: 64.07 kg
- NOx: 9.36 kg

**Alternative: 8,000 CFM**

**Initial Cost Data (not Discounted)**

**Initial Capital Costs**

(adjusted for price escalation)

Initial Capital Costs for All Components: $0

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost-Phasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Portion</td>
</tr>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Total (for Component):** $0

**Energy Costs: Electricity Savings**

(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage kWh</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>-3,923.0</td>
<td>$0.07700</td>
<td>-$302</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Chilled Water Saved**

(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage Therm</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>3,141.6</td>
<td>$0.88750</td>
<td>$2,788</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Steam Saved**

(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage Therm</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>128.4</td>
<td>$0.91400</td>
<td>$117</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Life-Cycle Cost Analysis**

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>
## Energy Costs

<table>
<thead>
<tr>
<th></th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$33,280</td>
<td>$2,603</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Energy):</strong></td>
<td>$33,280</td>
<td>$2,603</td>
</tr>
</tbody>
</table>

### Operating, Maintenance & Repair Costs

Component:

<table>
<thead>
<tr>
<th>Annual Recurring Costs</th>
<th>$-101,926</th>
<th>$-57,973</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for OM&amp;R):</strong></td>
<td>$-101,926</td>
<td>$-57,973</td>
</tr>
</tbody>
</table>

### Replacements to Capital Components

Component:

| $0 | $0 |
| **Subtotal (for Replacements):** | $0 | $0 |

### Residual Value of Original Capital Components

Component:

| $0 | $0 |
| **Subtotal (for Residual Value):** | $0 | $0 |

### Residual Value of Capital Replacements

Component:

| $0 | $0 |
| **Subtotal (for Residual Value):** | $0 | $0 |

### Total Life-Cycle Cost

| $-68,646 | $-5,370 |

## Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity Savings:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-707.01 kg</td>
<td>-17,674.68 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-5.71 kg</td>
<td>-142.64 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-0.83 kg</td>
<td>-20.83 kg</td>
</tr>
<tr>
<td><strong>Chilled Water Saved:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>16,593.23 kg</td>
<td>414,819.28 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>133.91 kg</td>
<td>3,347.72 kg</td>
</tr>
</tbody>
</table>
NOx  19.56 kg  488.90 kg

Steam Saved:

CO2  678.02 kg  16,950.07 kg
SO2  5.47 kg  136.79 kg
NOx  0.80 kg  19.98 kg

Total:

CO2  16,564.24 kg  414,094.66 kg
SO2  133.68 kg  3,341.87 kg
NOx  19.52 kg  488.05 kg

Alternative: 15,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)

Initial Capital Costs for All Components:  $0

Component:
Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component)  $0

Energy Costs: Electricity Savings
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-6,658.0 kWh</td>
<td>$0.07700</td>
<td>-$513</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,876.6 Therm</td>
<td>$0.08750</td>
<td>$5,216</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>239.5 Therm</td>
<td>$0.091400</td>
<td>$219</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

Initial Capital Costs  Present Value  Annual Value

<table>
<thead>
<tr>
<th>Energy Costs</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>
## Energy Costs

<table>
<thead>
<tr>
<th>Component</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$62,915</td>
<td>$4,922</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Energy):</strong></td>
<td><strong>$62,915</strong></td>
<td><strong>$4,922</strong></td>
</tr>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

## Operating, Maintenance & Repair Costs

<table>
<thead>
<tr>
<th>Component</th>
<th>Annually Recurring Costs</th>
<th>Non-Annually Recurring Costs</th>
<th><strong>Subtotal (for OM&amp;R):</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-123,678</td>
<td>$-9,675</td>
<td><strong>$-123,678</strong></td>
</tr>
</tbody>
</table>

## Replacements to Capital Components

| Component                        | $0     | $0         |
| **Subtotal (for Replacements):** | **$0** | **$0**     |

## Residual Value of Original Capital Components

| Component                        | $0     | $0         |
| **Subtotal (for Residual Value):** | **$0** | **$0**     |

## Residual Value of Capital Replacements

| Component                        | $0     | $0         |
| **Subtotal (for Residual Value):** | **$0** | **$0**     |

## Total Life-Cycle Cost

<table>
<thead>
<tr>
<th></th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>$-60,763</strong></td>
<td><strong>$-4,753</strong></td>
</tr>
</tbody>
</table>

## Emissions Summary

### Electricity Savings:

<table>
<thead>
<tr>
<th>Energy</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>-1,199.91 kg</td>
<td>-29,996.95 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-9.68 kg</td>
<td>-242.08 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-1.41 kg</td>
<td>-35.35 kg</td>
</tr>
</tbody>
</table>

### Chilled Water Saved:

<table>
<thead>
<tr>
<th>Energy</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>31,039.09 kg</td>
<td>775,956.06 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>250.50 kg</td>
<td>6,262.21 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>36.58 kg</td>
<td>914.53 kg</td>
</tr>
</tbody>
</table>
Steam Saved:

- **CO2**: 1,264.83 kg 31,619.80 kg
- **SO2**: 10.21 kg 255.18 kg
- **NOx**: 1.49 kg 37.27 kg

Total:

- **CO2**: 31,104.01 kg 777,578.91 kg
- **SO2**: 251.02 kg 6,275.31 kg
- **NOx**: 36.66 kg 916.44 kg

**Alternative: 30,000 CFM**

**Initial Cost Data (not Discounted)**

**Initial Capital Costs**  
(adjusted for price escalation)

**Initial Capital Costs for All Components**: $0

**Component: Copy of:**

**Cost-Phasing**

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Total (for Component)**: $0

**Energy Costs: Electricity Savings**  
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>-10,079.0 kWh</td>
<td>$0.07700</td>
<td>-$776</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Chilled Water Saved**  
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>11,476.1 Therm</td>
<td>$0.88750</td>
<td>$10,185</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Steam Saved**  
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>471.6 Therm</td>
<td>$0.91400</td>
<td>$431</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Life-Cycle Cost Analysis**

**Present Value**  
**Annual Value**

- **Initial Capital Costs**: $0 $0

**Energy Costs**

- **Energy Consumption Costs**: $125,786 $9,840
Energy Demand Charges $0  $0
Energy Utility Rebates  $0  $0

Subtotal (for Energy): $125,786  $9,840

Water Usage Costs $0  $0
Water Disposal Costs $0  $0

Operating, Maintenance & Repair Costs
Component: Copy of:
   Annually Recurring Costs  -$182,184  -$14,252
   Non-Annually Recurring Costs  $0  $0

Subtotal (for OM&R):  -$182,184  -$14,252

Replacements to Capital Components
Component: Copy of:

Subtotal (for Replacements):  $0  $0

Residual Value of Original Capital Components
Component: Copy of:

Subtotal (for Residual Value):  $0  $0

Residual Value of Capital Replacements
Component: Copy of:

Subtotal (for Residual Value):  $0  $0

Total Life-Cycle Cost  -$56,398  -$4,412

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-1,816.45 kg</td>
<td>-45,409.93 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-14.66 kg</td>
<td>-366.47 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-2.14 kg</td>
<td>-53.52 kg</td>
</tr>
<tr>
<td>Chilled Water Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>60,614.08 kg</td>
<td>1,515,310.41 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>489.17 kg</td>
<td>12,229.03 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>71.44 kg</td>
<td>1,785.92 kg</td>
</tr>
<tr>
<td>Steam Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>2,490.62 kg</td>
<td>62,263.82 kg</td>
</tr>
</tbody>
</table>
Alternative: 50,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component: Copy of: Copy of:
Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity Savings
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-22,169.0 kWh</td>
<td>$0.07700</td>
<td>-$1,707</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>19,219.2 Therm</td>
<td>$0.88750</td>
<td>$17,057</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>783.9 Therm</td>
<td>$0.91400</td>
<td>$716</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

<table>
<thead>
<tr>
<th>Energy Consumption Costs</th>
<th>$205,381</th>
<th>$16,066</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Equipment O&amp;M</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>
### Energy Utility Rebates

<table>
<thead>
<tr>
<th></th>
<th>$0</th>
<th>$0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtotal (for Energy)</td>
<td>$205,381</td>
<td>$16,066</td>
</tr>
</tbody>
</table>

### Water Usage Costs

|                          | $0    | $0    |

|                          | $0    | $0    |

### Water Disposal Costs

|                          | $0    | $0    |

### Operating, Maintenance & Repair Costs

<table>
<thead>
<tr>
<th>Component: Copy of: Copy of:</th>
<th>Annually Recurring Costs</th>
<th>Non-Annually Recurring Costs</th>
<th>$0</th>
<th>$0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtotal (for OM&amp;R):</td>
<td>$306,696</td>
<td>$23,992</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

### Replacements to Capital Components

| Component: Copy of: Copy of: | $0 | $0 |

|                          | $0 | $0 |

|                          | $0 | $0 |

### Residual Value of Original Capital Components

| Component: Copy of: Copy of: | $0 | $0 |

|                          | $0 | $0 |

### Residual Value of Capital Replacements

| Component: Copy of: Copy of: | $0 | $0 |

|                          | $0 | $0 |

### Total Life-Cycle Cost

|                          | $101,315 | $7,926 |

### Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity Savings</strong></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-3,995.32 kg 99,880.21 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-32.24 kg 806.06 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-4.71 kg 117.72 kg</td>
</tr>
<tr>
<td><strong>Chilled Water Saved</strong></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>101,511.50 kg 2,537,717.92 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>819.23 kg 20,480.18 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>119.64 kg 2,990.92 kg</td>
</tr>
<tr>
<td><strong>Steam Saved</strong></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>4,140.17 kg 103,501.48 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>33.41 kg 835.29 kg</td>
</tr>
</tbody>
</table>

**Note:** The negative values indicate reductions in emissions or energy usage.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>4.88 kg</td>
<td>121.99 kg</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>101,656.35 kg</td>
<td>2,541,339.18 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>820.40 kg</td>
<td>20,509.41 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>119.81 kg</td>
<td>2,995.19 kg</td>
</tr>
</tbody>
</table>
**Project Level Entries**

**General Information**

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>UT Austin Energy Recovery Study - 8760 (Year Round)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Austin, Tx</td>
</tr>
<tr>
<td>Analyst Name:</td>
<td>Travis Alexander</td>
</tr>
<tr>
<td>Discounting Convention:</td>
<td>End-of-Year</td>
</tr>
<tr>
<td>Discount Rate:</td>
<td>6%</td>
</tr>
</tbody>
</table>

**Key Dates**

| Base Date:       | 1-Jan-08                                           |
| Length of Study Period: | 25 Years                                     |

**Life-Cycle Analysis Description:**

This LCC was performed to determine at what amount of outside air justifies the increase of price for outside air units with energy recovery compared to ones without energy recovery. The input values for the LCC were determined by taking the difference in costs between the two types of units. A positive LCC total means the energy recovery unit is justified. It was assumed that these units ran 8760 hours a year. The analysis looked at outside air units ranging from 1000 CFM to 50,000 CFM.

**Summary of Results:**

ASHRAE 90.1 establishes minimum requirements; however, based on this analysis. For the range of CFM reviewed, outside air units over 8,000 CFM should be evaluated for the use of exhaust energy recovery.

(Add as many alternates as are needed)

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>1,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td>The alternate was used to determine if the increase of price for 1,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

| Alternate Name: | 1,000 CFM |

### OM&R Replacement Cost

| Cost Name: Capital Cost | Calculated Annual Simple: -$2,229 |
| Cost Name: Maintenance | Calculated Annual Simple: -$2,000 |

### Electricity Costs

| Annual Consumption: -1,702 | Units: Watts-Hours | Price/Unit: $0.077 |

### Chilled Water Costs

| Annual Consumption: 1,423 | Units: Therm | Price/Unit: $0.8875 |

### Steam Costs

| Annual Consumption: 98 | Units: Therm | Price/Unit: $0.914 |

### Water Costs

| Annual Water Usage: N/A | Units: N/A | Price/Unit: N/A | Price Escalation Rates: N/A |

### Non-Annually Recurring O&M and Repair Cost

| Years/Months: N/A | Amount: N/A | Annual Rate of Increase: N/A |
Alternative Level Entries

| Alternate Name: | 2,000 CFM |

OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculated Annual Simple:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-$2,112</td>
<td></td>
</tr>
</tbody>
</table>

Cost Name: Maintenance

<table>
<thead>
<tr>
<th>Calculated Annual Simple:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-$2,000</td>
<td></td>
</tr>
</tbody>
</table>

Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>-3,909</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Watts-Hours</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>2,482</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>177</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

| Alternate Name: | 4,000 CFM |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Capital Cost</th>
<th>Calculated Annual Simple:</th>
<th>-$1,877</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Name:</td>
<td>Maintenance</td>
<td>Calculated Annual Simple:</td>
<td>-$2,000</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>-9,184</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Watts-Hours</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>4,995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>351</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

| Alternate Name | 8,000 CFM |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name</th>
<th>Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple</td>
<td>-$5,222</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Name</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated Annual Simple</td>
<td>-$2,000</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>-14,790</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Watts-Hours</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>10,293</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>726</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Design Construction Standards, Revised November 2007
### Alternative Level Entries

| Alternate Name: | 15,000 CFM |

### OM&R Replacement Cost

| Cost Name: | Capital Cost |
| Calculated Annual Simple: | -$6,923 |
| Cost Name: | Maintenance |
| Calculated Annual Simple: | -$2,000 |

### Electricity Costs

| Annual Consumption: | -25,079 |
| Units: | Watts-Hours |
| Price/Unit: | $0.077 |

### Chilled Water Costs

| Annual Consumption: | 19,253 |
| Units: | Therm |
| Price/Unit: | $0.8875 |

### Steam Costs

| Annual Consumption: | 1,355 |
| Units: | Therm |
| Price/Unit: | $0.914 |

### Water Costs

| Annual Water Usage: | N/A |
| Units: | N/A |
| Price/Unit: | N/A |
| Price Escalation Rates: | N/A |

### Non-Annually Recurring O&M and Repair Cost

<p>| Years/Months: | N/A |
| Amount: | N/A |
| Annual Rate of Increase: | N/A |</p>
<table>
<thead>
<tr>
<th>Alternative Level Entries</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Name:</td>
<td>30,000 CFM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OM&amp;R Replacement Cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Name:</td>
<td>Capital Cost</td>
</tr>
<tr>
<td>Calculated Annual Simple:</td>
<td>-$11,499</td>
</tr>
<tr>
<td>Cost Name:</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Calculated Annual Simple:</td>
<td>-$2,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electricity Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Consumption:</td>
<td>-38,121</td>
</tr>
<tr>
<td>Units:</td>
<td>Watts-Hours</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chilled Water Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Consumption:</td>
<td>37,598</td>
</tr>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Steam Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Consumption:</td>
<td>2,668</td>
</tr>
<tr>
<td>Units:</td>
<td>Therm</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Water Usage:</td>
<td>N/A</td>
</tr>
<tr>
<td>Units:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price/Unit:</td>
<td>N/A</td>
</tr>
<tr>
<td>Price Escalation Rates:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Annually Recurring O&amp;M and Repair Cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Years/Months:</td>
<td>N/A</td>
</tr>
<tr>
<td>Amount:</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Rate of Increase:</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Alternative Level Entries

| Alternate Name: | 50,000 CFM |

### OM&R Replacement Cost

<table>
<thead>
<tr>
<th>Cost Name:</th>
<th>Calculated Annual Simple:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>-$21,239</td>
</tr>
<tr>
<td>Maintenance</td>
<td>-$2,000</td>
</tr>
</tbody>
</table>

### Electricity Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>Units:</th>
<th>Price/Unit:</th>
</tr>
</thead>
<tbody>
<tr>
<td>83,374</td>
<td>Watts-Hours</td>
<td>$0.077</td>
</tr>
</tbody>
</table>

### Chilled Water Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>Units:</th>
<th>Price/Unit:</th>
</tr>
</thead>
<tbody>
<tr>
<td>62,966</td>
<td>Therm</td>
<td>$0.8875</td>
</tr>
</tbody>
</table>

### Steam Costs

<table>
<thead>
<tr>
<th>Annual Consumption:</th>
<th>Units:</th>
<th>Price/Unit:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,079</td>
<td>Therm</td>
<td>$0.914</td>
</tr>
</tbody>
</table>

### Water Costs

<table>
<thead>
<tr>
<th>Annual Water Usage:</th>
<th>Units:</th>
<th>Price/Unit:</th>
<th>Price Escalation Rates:</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Non-Annually Recurring O&M and Repair Cost

<table>
<thead>
<tr>
<th>Years/Months:</th>
<th>Amount:</th>
<th>Annual Rate of Increase:</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Alternate Name:</td>
<td>2,000 CFM</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Alternate Description:</td>
<td>The alternate was used to determine if the increase of price for 2,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>4,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td>The alternate was used to determine if the increase of price for 4,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>8,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td>The alternate was used to determine if the increase of price for 8,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>15,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td>The alternate was used to determine if the increase of price for 15,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th>30,000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td>The alternate was used to determine if the increase of price for 30,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
<tr>
<td>Alternate Name:</td>
<td>50,000 CFM</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
</tr>
<tr>
<td>Alternate Description:</td>
<td>The alternate was used to determine if the increase of price for 50,000 CFM outside air units with energy recovery compared to ones without energy recovery are justified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Description:</td>
<td></td>
</tr>
</tbody>
</table>
DESIGN AND CONSTRUCTION STANDARD
NIST BLCC 5.3-07: Detailed LCC Analysis
Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

General Information
File Name: C:\Program Files\BLCC5\projects\UT Austin Energy Recovery Study - 8760.xml
Date of Study: Wed Jan 23 09:26:41 CST 2008
Analysis Type: FEMP Analysis, Energy Project
Project Name: UT Austin Energy Recovery Study - 8760
Project Location: Texas
Analyst: Travis Alexander
Base Date: January 1, 2008
Service Date: January 1, 2008
Study Period: 25 years 0 months (January 1, 2008 through December 31, 2032)
Discount Rate: 6%
Discounting Convention: End-of-Year

Discount and Escalation Rates are NOMINAL (inclusive of general inflation)

Alternative: 1,000 CFM
Initial Cost Data (not Discounted)
Initial Capital Costs (adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component: Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity Savings (base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1,702.0 kWh</td>
<td>$0.07700</td>
<td>-$131</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water Saved (base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,422.8 Therm</td>
<td>$0.88750</td>
<td>$1,263</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved (base-year dollars)
<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td></td>
<td>98.0 Therm</td>
<td>$0.91400</td>
<td>$90</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Life-Cycle Cost Analysis**

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Capital Costs</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs**

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$15,611</td>
<td>$1,221</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for Energy):</strong></td>
<td>$15,611</td>
<td>$1,221</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Operating, Maintenance & Repair Costs**

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annually Recurring Costs</td>
<td>-$63,672</td>
<td>-$4,981</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal (for OM&amp;R):</strong></td>
<td>-$63,672</td>
<td>-$4,981</td>
</tr>
</tbody>
</table>

**Replacements to Capital Components**

<table>
<thead>
<tr>
<th>Component:</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (for Replacements):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Residual Value of Original Capital Components**

<table>
<thead>
<tr>
<th>Component:</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Residual Value of Capital Replacements**

<table>
<thead>
<tr>
<th>Component:</th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (for Residual Value):</strong></td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Total Life-Cycle Cost**

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-$48,061</td>
<td>-$3,760</td>
<td></td>
</tr>
</tbody>
</table>
### Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity Savings:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-306.74 kg</td>
<td>-7,668.19 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-2.48 kg</td>
<td>-61.88 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-0.36 kg</td>
<td>-9.04 kg</td>
</tr>
<tr>
<td><strong>Chilled Water Saved:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>7,514.80 kg</td>
<td>187,864.96 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>60.65 kg</td>
<td>1,516.13 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>8.86 kg</td>
<td>221.41 kg</td>
</tr>
<tr>
<td><strong>Steam Saved:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>517.56 kg</td>
<td>12,938.67 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>4.18 kg</td>
<td>104.42 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>0.61 kg</td>
<td>15.25 kg</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>7,725.63 kg</td>
<td>193,135.45 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>62.35 kg</td>
<td>1,558.66 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>9.11 kg</td>
<td>227.63 kg</td>
</tr>
</tbody>
</table>

### Alternative: 2,000 CFM

**Initial Cost Data (not Discounted)**

**Initial Capital Costs**

*(adjusted for price escalation)*

Initial Capital Costs for All Components: $0

<table>
<thead>
<tr>
<th>Component:</th>
<th>Cost-Phasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Portion</td>
</tr>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
</tr>
<tr>
<td>Total (for Component)</td>
<td></td>
</tr>
</tbody>
</table>

**Energy Costs: Electricity Savings** *(base-year dollars)*

<table>
<thead>
<tr>
<th>Annual Usage</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3,909.0 kwh</td>
<td>$0.07700</td>
<td>-$301</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Chilled Water Saved** *(base-year dollars)*

<table>
<thead>
<tr>
<th>Annual Usage</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
</table>
Energy Costs: Steam Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average Annual Usage</th>
<th>Average Price/Unit</th>
<th>Average Annual Cost</th>
<th>Average Annual Demand</th>
<th>Average Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>176.9 Therm</td>
<td>$0.91400</td>
<td>$162</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

- Energy Consumption Costs: $26,382 / $2,064
- Energy Demand Charges: $0 / $0
- Energy Utility Rebates: $0 / $0

Subtotal (for Energy): $26,382 / $2,064

Water Usage Costs: $0 / $0
Water Disposal Costs: $0 / $0

Operating, Maintenance & Repair Costs

Component: Annually Recurring Costs
- $62,172 / $4,864
Component: Non-Annually Recurring Costs
- $0 / $0

Subtotal (for OM&R): $62,172 / $4,864

Replacements to Capital Components

Component: $0 / $0

Subtotal (for Replacements): $0 / $0

Residual Value of Original Capital Components

Component: $0 / $0

Subtotal (for Residual Value): $0 / $0

Residual Value of Capital Replacements

Component: $0 / $0
Subtotal (for Residual Value): $0  $0

Total Life-Cycle Cost: -$35,791  -$2,800

## Emissions Summary

### Electricity Savings:

- **CO2**
  - Annual: 704.48 kg
  - Life-Cycle: -17,611.61 kg
- **SO2**
  - Annual: -5.69 kg
  - Life-Cycle: -142.13 kg
- **NOx**
  - Annual: -0.83 kg
  - Life-Cycle: -20.76 kg

### Chilled Water Saved:

- **CO2**
  - Annual: 13,110.95 kg
  - Life-Cycle: 327,764.80 kg
- **SO2**
  - Annual: 105.81 kg
  - Life-Cycle: 2,645.17 kg
- **NOx**
  - Annual: 15.45 kg
  - Life-Cycle: 386.30 kg

### Steam Saved:

- **CO2**
  - Annual: 934.56 kg
  - Life-Cycle: 23,363.29 kg
- **SO2**
  - Annual: 7.54 kg
  - Life-Cycle: 188.55 kg
- **NOx**
  - Annual: 1.10 kg
  - Life-Cycle: 27.54 kg

### Total:

- **CO2**
  - Annual: 13,341.02 kg
  - Life-Cycle: 333,516.48 kg
- **SO2**
  - Annual: 107.67 kg
  - Life-Cycle: 2,691.58 kg
- **NOx**
  - Annual: 15.72 kg
  - Life-Cycle: 393.08 kg

## Alternative: 4,000 CFM

### Initial Cost Data (not Discounted)

#### Initial Capital Costs

(adjusted for price escalation)

Initial Capital Costs for All Components: $0

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost-Phasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Portion</td>
</tr>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
</tr>
</tbody>
</table>

Total (for Component) $0

### Energy Costs: Electricity Savings

(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>-9,184.0 kWh</td>
<td>$0.07700</td>
<td>-$707</td>
<td>$0</td>
</tr>
</tbody>
</table>
Energy Costs: Chilled Water Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Price/Unit</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>4,994.9 Therm</td>
<td>$0.88750</td>
<td>$4,433</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Price/Unit</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>351.1 Therm</td>
<td>$0.91400</td>
<td>$321</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

Present Value | Annual Value
Initial Capital Costs | $0 | $0

Energy Costs

- Energy Consumption Costs: $51,730 | $4,047
- Energy Demand Charges: $0 | $0
- Energy Utility Rebates: $0 | $0

Subtotal (for Energy): $51,730 | $4,047

Water Usage Costs | $0 | $0
Water Disposal Costs | $0 | $0

Operating, Maintenance & Repair Costs

Component:
- Annually Recurring Costs: $-59,172 | $-4,629
- Non-Annually Recurring Costs: $0 | $0

Subtotal (for OM&R): $-59,172 | $-4,629

Replacements to Capital Components

Component: $0 | $0

Subtotal (for Replacements): $0 | $0

Residual Value of Original Capital Components

Component: $0 | $0

Subtotal (for Residual Value): $0 | $0
Residual Value of Capital Replacements

Component: $0 $0

----------------- -----------------

Subtotal (for Residual Value): $0 $0

Total Life-Cycle Cost $-7,442 $-582

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-1,655.15 kg</td>
<td>-41,377.59 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-13.36 kg</td>
<td>-333.93 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-1.95 kg</td>
<td>-48.77 kg</td>
</tr>
</tbody>
</table>

Chilled Water Saved:

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>26,381.83 kg</td>
<td>659,527.79 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>212.91 kg</td>
<td>5,322.60 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>31.09 kg</td>
<td>777.31 kg</td>
</tr>
</tbody>
</table>

Steam Saved:

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>1,854.38 kg</td>
<td>46,358.19 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>14.97 kg</td>
<td>374.13 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>2.19 kg</td>
<td>54.64 kg</td>
</tr>
</tbody>
</table>

Total:

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>26,581.06 kg</td>
<td>664,508.39 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>214.52 kg</td>
<td>5,362.79 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>31.33 kg</td>
<td>783.18 kg</td>
</tr>
</tbody>
</table>

Alternative: 8,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs
(adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component:

Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

----------------- -----------------

Total (for Component) $0

Energy Costs: Electricity Savings
(base-year dollars)
Average Annual Usage  Average Price/Unit  Average Annual Cost  Average Annual Demand  Average Annual Rebate
-14,790.0 kWh  $0.07700  -$1,139  $0  $0

Energy Costs: Chilled Water Saved
(base-year dollars)
Average Annual Usage  Average Price/Unit  Average Annual Cost  Average Annual Demand  Average Annual Rebate
10,293.0 Therm  $0.88750  $9,135  $0  $0

Energy Costs: Steam Saved
(base-year dollars)
Average Annual Usage  Average Price/Unit  Average Annual Cost  Average Annual Demand  Average Annual Rebate
726.3 Therm  $0.91400  $664  $0  $0

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$110,703</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
</tr>
</tbody>
</table>

Subtotal (for Energy):  
$110,703  $8,660

Water Usage Costs
$0  $0

Water Disposal Costs
$0  $0

Operating, Maintenance & Repair Costs

Component:
An Annually Recurring Costs  
$-101,926  $-7,973
Non-Annually Recurring Costs
$0  $0

Subtotal (for OM&R):  
$-101,926  $-7,973

Replacements to Capital Components

Component:
$0  $0

Subtotal (for Replacements):  
$0  $0
Residual Value of Original Capital Components

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Residual Value of Capital Replacements

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Total Life-Cycle Cost $8,777 $687

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-2,665.47 kg</td>
<td>-66,634.87 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-21.51 kg</td>
<td>-537.76 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-3.14 kg</td>
<td>-78.53 kg</td>
</tr>
<tr>
<td>Chilled Water Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>54,365.26 kg</td>
<td>1,359,094.30 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>438.74 kg</td>
<td>10,968.32 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>64.07 kg</td>
<td>1,601.81 kg</td>
</tr>
<tr>
<td>Steam Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>3,836.26 kg</td>
<td>95,903.85 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>30.96 kg</td>
<td>773.97 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>4.52 kg</td>
<td>113.03 kg</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>55,536.05 kg</td>
<td>1,388,363.28 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>448.19 kg</td>
<td>11,204.53 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>65.45 kg</td>
<td>1,636.31 kg</td>
</tr>
</tbody>
</table>

Alternative: 15,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs

(adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component: $0

Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

----------  ----------
Total (for Component) $0

**Energy Costs: Electricity Savings**
*(base-year dollars)*

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>-25,079.0 kWh</td>
<td>$0.07700</td>
<td>-$1,931</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Chilled Water Saved**
*(base-year dollars)*

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>19,253.0 Therm</td>
<td>$0.88750</td>
<td>$17,087</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs: Steam Saved**
*(base-year dollars)*

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
<td>Annual Rebate</td>
</tr>
<tr>
<td>1,354.9 Therm</td>
<td>$0.91400</td>
<td>$1,238</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Life-Cycle Cost Analysis**

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Energy Costs**

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$209,572</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
</tr>
</tbody>
</table>

Subtotal (for Energy): $209,572 $16,394

**Water Usage Costs** $0 $0

**Water Disposal Costs** $0 $0

**Operating, Maintenance & Repair Costs**

Component:

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annually Recurring Costs</td>
<td>-$123,678</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>

Subtotal (for OM&R): -$123,678 -$9,675

**Replacements to Capital Components**
Component: $0 $0

Subtotal (for Replacements): $0 $0

Residual Value of Original Capital Components
Component: $0 $0

Subtotal (for Residual Value): $0 $0

Residual Value of Capital Replacements
Component: $0 $0

Subtotal (for Residual Value): $0 $0

Total Life-Cycle Cost

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-4,519.76 kg</td>
<td>-112,990.93 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-36.48 kg</td>
<td>-911.87 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-5.33 kg</td>
<td>-133.17 kg</td>
</tr>
<tr>
<td>Chilled Water Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>101,689.97 kg</td>
<td>2,542,179.58 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>820.67 kg</td>
<td>20,516.19 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>119.85 kg</td>
<td>2,996.18 kg</td>
</tr>
<tr>
<td>Steam Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>7,156.22 kg</td>
<td>178,900.72 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>57.75 kg</td>
<td>1,443.79 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>8.43 kg</td>
<td>210.85 kg</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>104,326.43 kg</td>
<td>2,608,089.37 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>841.95 kg</td>
<td>21,048.10 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>122.96 kg</td>
<td>3,073.86 kg</td>
</tr>
</tbody>
</table>

**Alternative: 30,000 CFM**

Initial Cost Data (not Discounted)

**Initial Capital Costs**
(adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component:
Cost-Phasing

Date Portion Yearly Cost
January 1, 2008 100% $0

Total (for Component) $0

Energy Costs: Electricity Savings
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-38,121.0 kWh</td>
<td>$0.07700</td>
<td>-$2,935</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>37,597.8 Therm</td>
<td>$0.88750</td>
<td>$33,368</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved
(base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Price/Unit</th>
<th>Annual Cost</th>
<th>Annual Demand</th>
<th>Annual Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,668.0 Therm</td>
<td>$0.91400</td>
<td>$2,439</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Costs</td>
<td></td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$420,201</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
</tr>
<tr>
<td>Subtotal (for Energy):</td>
<td>$420,201</td>
</tr>
<tr>
<td>Water Usage Costs</td>
<td>$0</td>
</tr>
<tr>
<td>Water Disposal Costs</td>
<td>$0</td>
</tr>
<tr>
<td>Operating, Maintenance &amp; Repair Costs</td>
<td></td>
</tr>
<tr>
<td>Component:</td>
<td></td>
</tr>
<tr>
<td>Annually Recurring Costs</td>
<td>-$182,184</td>
</tr>
<tr>
<td>Non-Annually Recurring Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>
Subtotal (for OM&R): $182,184 $14,252

Replacements to Capital Components

Component: $0 $0

Subtotal (for Replacements): $0 $0

Residual Value of Original Capital Components

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Residual Value of Capital Replacements

Component: $0 $0

Subtotal (for Residual Value): $0 $0

Total Life-Cycle Cost:

$238,017 $18,619

Emissions Summary

<table>
<thead>
<tr>
<th>Energy Name</th>
<th>Annual</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-6,870.20 kg</td>
<td>-171,750.35 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>-55.44 kg</td>
<td>-1,386.08 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>-8.10 kg</td>
<td>-202.42 kg</td>
</tr>
<tr>
<td>Chilled Water Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>198,583.24 kg</td>
<td>4,964,445.01 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,602.63 kg</td>
<td>40,064.64 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>234.05 kg</td>
<td>5,851.02 kg</td>
</tr>
<tr>
<td>Steam Saved:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>14,091.67 kg</td>
<td>352,282.13 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>113.72 kg</td>
<td>2,843.03 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>16.61 kg</td>
<td>415.19 kg</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>205,804.71 kg</td>
<td>5,144,976.78 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>1,660.91 kg</td>
<td>41,521.59 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>242.56 kg</td>
<td>6,063.80 kg</td>
</tr>
</tbody>
</table>

Alternative: 50,000 CFM

Initial Cost Data (not Discounted)

Initial Capital Costs
Initial Capital Costs (adjusted for price escalation)

Initial Capital Costs for All Components: $0

Component:
Cost-Phasing

<table>
<thead>
<tr>
<th>Date</th>
<th>Portion</th>
<th>Yearly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1, 2008</td>
<td>100%</td>
<td>$0</td>
</tr>
</tbody>
</table>

Total (for Component) $0

Energy Costs: Electricity Savings (base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>-83,374.0 kWh</td>
<td>$0.07700</td>
<td>-$6,420</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Chilled Water Saved (base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>62,965.8 Therm</td>
<td>$0.88750</td>
<td>$55,882</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs: Steam Saved (base-year dollars)

<table>
<thead>
<tr>
<th>Average</th>
<th>Average</th>
<th>Average</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Usage</td>
<td>Price/Unit</td>
<td>Annual Cost</td>
<td>Annual Demand</td>
</tr>
<tr>
<td>6,079.0 Therm</td>
<td>$0.91400</td>
<td>$5,556</td>
<td>$0</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Costs</td>
<td>$0</td>
</tr>
</tbody>
</table>

Energy Costs

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Annual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption Costs</td>
<td>$703,313</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$0</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
</tr>
</tbody>
</table>

Subtotal (for Energy): $703,313 $55,019

Water Usage Costs $0 $0

Water Disposal Costs $0 $0

Operating, Maintenance & Repair Costs
Operating, Maintenance & Repair Costs

Component:

Annually Recurring Costs  
- $306,696  
- $23,992  

Non-Annually Recurring Costs  
$0  
$0  

Subtotal (for OM&R):  
- $306,696  
- $23,992  

Replacements to Capital Components

Component:  
$0  
$0  

Subtotal (for Replacements):  
$0  
$0  

Residual Value of Original Capital Components

Component:  
$0  
$0  

Subtotal (for Residual Value):  
$0  
$0  

Residual Value of Capital Replacements

Component:  
$0  
$0  

Subtotal (for Residual Value):  
$0  
$0  

Total Life-Cycle Cost  
$396,617  
$31,026  

Emissions Summary

Energy Name    Annual    Life-Cycle
Electricity Savings:
CO2            -15,025.74 kg  
SO2            -121.26 kg    
NOx            -17.71 kg     

Chilled Water Saved:
CO2            332,571.00 kg  
SO2            2,683.95 kg   
NOx            391.96 kg     

Steam Saved:
CO2            32,107.91 kg   
SO2            259.12 kg     
NOx            37.84 kg      

Total:
CO2            349,653.17 kg  
SO2            2,821.81 kg   
NOx            412.10 kg     

$k$
Design & Construction Standard Detail Drawings:

All Standard Detail Drawings presented herein are intended to assist architects, engineers, other design professionals, contractors and UT staff in understanding the preferences of The University of Texas at Austin in the development, maintenance, construction and repair of its facilities. These Detail Drawings are intended to be used as guidelines. Detail Drawing documents require modification to meet the conditions and appurtenances of each project; therefore the legal responsibility for project document preparation shall continue to reside with the Design Professional. Refer to the Welcome Page for additional requirements. The Detail Drawings were created in AutoCAD 2007 file format; AutoCAD is a registered trademark of Autodesk Inc.

Please Note: These Detail Drawing documents are for use by The University of Texas at Austin, its consultants and contractors and remain the property of The University of Texas at Austin at all times.

Division 21: Fire Protection:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JOCKEY PUMP DETAIL</td>
</tr>
</tbody>
</table>

Division 22: “Plumbing”

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P-22-1-3</td>
<td>FLOOR DRAIN INSTALLATION DETAIL</td>
</tr>
<tr>
<td>P-22-1-4</td>
<td>FLOOR DRAIN INSTALLATION DETAIL</td>
</tr>
<tr>
<td>P-22-1-12</td>
<td>FLOOR DRAIN INSTALLATION DETAIL</td>
</tr>
<tr>
<td>P-22-1-13</td>
<td>FLOOR DRAIN INSTALLATION DETAIL</td>
</tr>
<tr>
<td>P-22-2-2</td>
<td>PIPE SUPPORT DETAIL</td>
</tr>
<tr>
<td>P-22-2-5</td>
<td>PIPE SUPPORT DETAIL</td>
</tr>
<tr>
<td>P-22-2-6</td>
<td>MODULAR COMPRESSION PIPE SEAL AND SLEEVE DETAIL</td>
</tr>
<tr>
<td>P-22-2-7</td>
<td>PIPE SLEEVE DETAILS</td>
</tr>
<tr>
<td>P-22-2-8</td>
<td>WATER, WASTE &amp; VENT PIPING HANGERS &amp; SUPPORTS DETAIL</td>
</tr>
<tr>
<td>P-22-5-1</td>
<td>LAVATORY &amp; SINK CONNECTION DETAIL</td>
</tr>
<tr>
<td>P-22-5-5</td>
<td>LAVATORY &amp; SINK CONNECTION DETAIL</td>
</tr>
<tr>
<td>P-22-5-6</td>
<td>DETAIL: LAB SINK CONNECTION</td>
</tr>
</tbody>
</table>
Division 23: “Heating, Ventilating and Air Conditioning”

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-23-1-5</td>
<td>TYPICAL BRANCH DUCT WITH 45° CLINCH TAP DETAIL</td>
</tr>
<tr>
<td>M-23-1-6</td>
<td>TYPICAL BRANCH DUCT WITH CONICAL TAP DETAIL</td>
</tr>
<tr>
<td>M-23-1-10</td>
<td>LINED SOUND PLENUM</td>
</tr>
<tr>
<td>M-23-1-16</td>
<td>LATERAL MIXING TEE DETAIL</td>
</tr>
<tr>
<td>M-23-1-18</td>
<td>CEILING DIFFUSER CONNECTION DETAIL</td>
</tr>
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<td>M-23-1-19</td>
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<td>LATERAL MIXING TEE DETAIL</td>
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<td>M-23-1-32</td>
<td>VAV FUME HOOD DETAIL (BUILDINGS WITH PNEUMATIC CONTROLS)</td>
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<td>M-23-3-1</td>
<td>WATER PIPING HANGERS AND SUPPORTS DETAIL</td>
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<td>M-23-3-2</td>
<td>PIPE SLEEVE DETAIL</td>
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<td>WATER PIPING HANGERS AND SUPPORTS DETAIL</td>
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<td>STEAM HEATING COIL PIPING DIAGRAM PREHEAT POSITION</td>
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<td>CHILLED WATER INSULATION DETAIL AT AHU COIL</td>
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<td>CONDENSATE DRAIN DETAIL</td>
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<td>M-23-4-19</td>
<td>SCHEMATIC AIR BLEED/TEST VALVE SCHEMATIC</td>
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<td>PIPING DIAGRAM: STEAM TRAP AT END OF MAIN</td>
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<td>M-23-4-25</td>
<td>INSTRUMENT TAPS IN PIPING DETAIL</td>
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<td>SPLIT CHILLED WATER COIL PIPING DIAGRAM</td>
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<td>M-23-4-31</td>
<td>INSTRUMENTATION &amp; MISCELLANEOUS PIPING TAPS (BELOW AMBIENT TEMP)</td>
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<td>COOLING COIL MOUNTING DETAILS</td>
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<td>STEAM CONDENSATE TANK &amp; DUPLEX PUMP DETAIL</td>
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<td>END SUCTION PUMP PIPING DETAIL</td>
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<td>AHU - FRONT ACCESS FILTER HOUSING DETAIL</td>
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<td>MIXING LATERAL CONTROL DIAGRAM</td>
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<td>LOW TEMPERATURE SAFETY MOUNTING DETAIL</td>
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<td>M-23-8-22</td>
<td>THERMOSTAT &amp; DAMPER CONTROLLER ASSEMBLY DETAIL</td>
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<tr>
<td>M-23-8-23</td>
<td>THERMOSTAT &amp; DAMPER CONTROLLER ASSEMBLY DETAIL</td>
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Instrumentation & Controls:
The following details involving pneumatic controls are applicable to existing renovations only.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1</td>
<td>AHU SMOKE MANAGEMENT SCHEMATIC</td>
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<td>2</td>
<td>VAV AIR HANDLER BAS SCHEMATIC</td>
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<td>3</td>
<td>HVAC AND FIRE ALARM SMOKE MANAGEMENT INTERFACE PANEL DETAIL</td>
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<td>4</td>
<td>VAV AIR HANDLER BAS SCHEMATIC &amp; INSTRUMENTATION SCHEMATIC</td>
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<tr>
<td>5</td>
<td>DC POWER SUPPLY Wiring</td>
</tr>
<tr>
<td>6</td>
<td>UTILITY POWER BAS SCHEMATIC</td>
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<tr>
<td>7</td>
<td>STEAM PRESSURE BAS SCHEMATIC</td>
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<td>DC POWER SUPPLY BAS SCHEMATIC</td>
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<td>9</td>
<td>LIQUID RECEIVER BAS SCHEMATIC</td>
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<td>CONDENSATE TEMPERATURE BAS SCHEMATIC</td>
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<td>SUMP PUMPS BAS SCHEMATIC</td>
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<td>FLOOD DETECTOR BAS SCHEMATIC</td>
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<td>PUMP BAS SCHEMATIC</td>
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<td>SINGLE ZONE AHU BAS SCHEMATIC</td>
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<td>18</td>
<td>INSERTION TEMPERATURE SENSOR THERMOWELL LOCATION - HORIZONTAL</td>
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<td>19</td>
<td>DETAIL SECTION A-A</td>
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<td>20</td>
<td>INSERTION TEMPERATURE SENSOR THERMOWELL LOCATION - VERTICAL PIPING</td>
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<td>DETAIL SECTION B-B</td>
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<td>22</td>
<td>INSERTION TEMPERATURE SENSOR THERMOWELL LOCATION - PIPE ELBOW</td>
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<td>23</td>
<td>BAS ENCLOSURE LAYOUT</td>
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<td>BAS FIELD INTERFACE PANEL LAYOUT</td>
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<tr>
<td>25</td>
<td>BAS RISER DIAGRAM - TYPICAL WITH BAS ZONE CONTROL</td>
</tr>
<tr>
<td>26</td>
<td>BAS RISER DIAGRAM - TYPICAL WITHOUT BAS ZONE CONTROL</td>
</tr>
<tr>
<td>27</td>
<td>MIXING LATERAL ELECTRIC ACTUATOR WIRING DETAIL</td>
</tr>
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<td>28</td>
<td>MIXING LATERAL CONTROLLER ENCLOSURE MOUNTING DETAIL</td>
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<td>29</td>
<td>MIXING LATERAL ENCLOSURE LAYOUT DETAIL</td>
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<td>ROOM SENSOR MOUNTING DETAIL</td>
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<td>OUTSIDE PRESSURE SENSOR</td>
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<td>32</td>
<td>INSTRUMENT AIR STATION</td>
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<td>33</td>
<td>AIR HANDLER INSTRUMENTATION</td>
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<td>34</td>
<td>ANNUNCIATOR WIRING DETAIL</td>
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<td>35</td>
<td>AHU SAFETY AVERAGING ELEMENT MOUNTING DETAIL</td>
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<td>36</td>
<td>WIRING FOR FANS &amp; PUMPS</td>
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<tr>
<td>37</td>
<td>THERMOSTAT &amp; DAMPER CONTROLLER ASSEMBLY DETAIL 1</td>
</tr>
<tr>
<td>38</td>
<td>THERMOSTAT &amp; DAMPER CONTROLLER ASSEMBLY DETAIL 2</td>
</tr>
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<td>39</td>
<td>LATERAL MIXING TEE DETAIL</td>
</tr>
<tr>
<td>40</td>
<td>MIXING LATERAL CONTROL DIAGRAM DETAIL</td>
</tr>
</tbody>
</table>
Energy Impact Statement, Description

For all new buildings and major renovations with a construction budget of $10 million or more, the design professional shall complete the attached Energy Impact Statement as required by the Design Phase Deliverables. The design professional shall refine and update the Energy Impact Statement throughout the three design phases as more detailed information regarding the project becomes available. For comparison, prior estimates are to be shown on subsequent updates of the Energy Impact Statement.

For those projects with a construction budget between $2 million and $10 million, the design professional shall perform a single iteration of the Energy Impact Statement as part of the Design Development Phase.

The following describes the general methodology to be used for each utility section. Provide supporting information with the Energy Impact Statement for each phase where required.

Legend:

ALL: Requirement for each phase
SD: Schematic Design Phase
DD: Design Development Phase
CD: Construction Document Phase

Electrical:
ALL: Describe methods and assumptions used to calculate electrical estimates.
SD: Can use watts per square foot.
    Identify any unusual loads.
    Estimates can be a developed using a computer simulation or a spreadsheet listing peak demand, estimated diversity and annual consumption.
DD & CD: Estimates based on actual design and not watts per square foot.
    Estimates can be a developed using a computer simulation program or a spreadsheet listing peak demand, estimated diversity and annual consumption.
    Indicate diversity assumptions or include schedules from computer simulation.

Low Pressure Steam:
ALL: Describe methods and assumptions used to calculate low pressure steam estimates.
    Provide list of significant loads showing peak demand and annual consumption.
SD: Heating consumption estimate can be developed using ASHRAE Degree Day Formula or Bin Estimate Method.
CD & DD: Develop heating consumption estimates using a computer simulation program utilizing 8,760 hours per year analysis such as Trane Trace, Carrier HAP or Elite EZDOE.
Energy Impact Statement, Page 2 of 5

165 PSI Steam:
ALL: Describe methods and assumptions used to calculate 165 PSI steam estimates. 
Provide list of significant loads showing peak demand and annual consumption.

Chilled Water:
ALL: Describe methods and assumptions used to calculate chilled water estimates. Provide list of significant loads showing peak demand and annual consumption. 
CD & DD: Develop chilled water cooling estimates using a computer simulation program utilizing 8,760 hours per year analysis such as Trane Trace, Carrier HAP or Elite EZDOE.

Domestic Cold Water:
ALL: Describe methods and assumptions used to calculate domestic cold water estimates. 
Provide fixture count summary and site source for estimating peak diversified demand.

Domestic Hot Water:
ALL: Describe methods and assumptions used to calculate domestic hot water estimates. 
Provide fixture count summary and site source for estimating peak diversified demand.

Natural Gas:
ALL: Describe methods and assumptions used to calculate natural gas estimates.

Storm Drainage System: 
ALL: Describe methods and assumptions used to calculate storm drainage estimates.
Energy Impact Statement, Page 3 of 5

Project Name: ___________________________ OFPC Project No.: _______________________

Building Description and Assumptions:

The design professional shall provide a brief narrative describing various building related items and assumptions used to complete the Energy Impact Statement. Among these are the following:

Building Gross Floor Area
Building Hours of Operation (breakdown for various key areas as required)
Utilities Required
Mechanical Systems Description
    Chilled Water Design Entering and Leaving Temperatures
    Assumed Design Residual Pressure for the Domestic Cold Water System
Electrical System Description
### Building Energy Summary

<table>
<thead>
<tr>
<th>Project Affected Gross Area, (GSF)</th>
<th>Schematic Phase</th>
<th>Design Development Phase</th>
<th>Construction Document Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Building Energy Consumption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Energy Input Converted to BTU, (MBTU/year)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Annual Building Energy Consumption per GSF, (BTU/year/GSF)</td>
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</table>

### Electrical:

<table>
<thead>
<tr>
<th>Maximum Demand, (kW)</th>
<th>Schematic Phase</th>
<th>Design Development Phase</th>
<th>Construction Document Phase</th>
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<tbody>
<tr>
<td>Annual Consumption, (kWh/year):</td>
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<td></td>
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<tr>
<td>Lighting</td>
<td>Not Required KWh KWhpeak Diversity</td>
<td>Not Required KWh KWhpeak Diversity</td>
<td></td>
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<tr>
<td>Miscellaneous Power</td>
<td>Not Required KWh KWhpeak Diversity</td>
<td>Not Required KWh KWhpeak Diversity</td>
<td></td>
</tr>
<tr>
<td>HVAC Equipment</td>
<td>Not Required KWh KWhpeak Diversity</td>
<td>Not Required KWh KWhpeak Diversity</td>
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### Low Pressure Steam:

<table>
<thead>
<tr>
<th>Peak Load, (lbs/hr):</th>
<th>Schematic Phase</th>
<th>Design Development Phase</th>
<th>Construction Document Phase</th>
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<tbody>
<tr>
<td>Summer</td>
<td></td>
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<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Annual Consumption, (MLB/yr):</td>
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<tr>
<td>Heating</td>
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<tr>
<td>Humidification</td>
<td>Not Required</td>
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<td></td>
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<tr>
<td>Air Conditioning</td>
<td>Not Required</td>
<td></td>
<td></td>
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<tr>
<td>Domestic Water Heating</td>
<td>Not Required</td>
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<tr>
<td>Process</td>
<td>Not Required</td>
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### 165 PSI Steam:

<table>
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<th>Peak Load, (lbs/hr):</th>
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<th>Design Development Phase</th>
<th>Construction Document Phase</th>
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<tbody>
<tr>
<td>Summer</td>
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<tr>
<td>Winter</td>
<td></td>
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<tr>
<td>Annual Consumption, (Lb/yr):</td>
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Design and Construction Standards, Revised November 2007 6.01.40-4
### Energy Impact Statement

**Project Name:** ____________________________  **OFPC Project No.:** _______________________

<table>
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<tr>
<th>Chilled Water:</th>
<th>Schematic Phase</th>
<th>Design Development Phase</th>
<th>Construction Document Phase</th>
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<tbody>
<tr>
<td>Peak Load, (tons/hour):</td>
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<td></td>
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<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Consumption, (ton-hours/year)</td>
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**Domestic Cold Water:**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Peak Cold Water Demand, (GPM)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Sanitary Demand, (GPM)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Annual Consumption,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(million gallons/year):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanitary Sewer</td>
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<td>Not Required</td>
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**Domestic Hot Water:**

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</thead>
<tbody>
<tr>
<td>Peak Demand, (CCF/hour)</td>
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<td></td>
</tr>
<tr>
<td>Annual Consumption,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CCF/year)</td>
<td></td>
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**Storm Drainage System:**

<p>| | | | |</p>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Design Storm Peak Volume, (GPM)</td>
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</tbody>
</table>
Energy Impact Statement

Project Name: **Example Building**  
OFPC Project No.: **12345**

**Building Description and Assumptions:**

The design professional shall provide a brief narrative describing various building related items and assumptions used to complete the Energy Impact Statement. Among these are the following:

Building Gross Floor Area  
Building Hours of Operation (breakdown for various key areas as required)  
Utilities Required  
Mechanical Systems Description  
   Chilled Water Design Entering and Leaving Temperatures  
   Assumed Design Residual Pressure for the Domestic Cold Water System  
Electrical System Description

**Example Building Data:**

General:
- Central Campus building with mix of offices and classrooms. Some small labs.

Building Gross Floor Area:
- 40,000 GSF (4 Stories @ 10,000 GSF each)

Building Hours of Operation (breakdown for various key areas as required):
- 7 a.m. - 6 p.m. and as further defined in the attached calculations and computer simulation input schedules.

Utilities Required:
- High pressure steam from central system.
- Domestic cold water from central system.
- Natural gas from campus distribution system.
- Electricity from central system.
- Chilled Water from central system.
- Fire protection (high pressure) water from central FWDS system in Speedway.
- Laboratory water for humidification from central system.
- Sanitary sewer to existing main in Speedway.
- Storm sewer to existing main in Speedway.

Mechanical Systems Description:
- Two air handling units located in the basement mechanical room.
- VAV boxes with hot water reheat coils.
- Hot water perimeter heating via steam/hot water heat exchanger.
- High pressure steam for autoclaves.
- 39 F Entering Chilled Water Temperature, 56 F Leaving Chilled Water Temperature.
- Assumed Design residual pressure for the Domestic Cold Water System is 30 psi.

Electrical System Description:
- Electrical feed will come from Central Campus feeder 21-2.
- No emergency generation is required.


### Energy Impact Statement

**Project Name:** Example Building  
**OFPC Project No.:** P1000XXX-03-001

<table>
<thead>
<tr>
<th>Building Energy Summary:</th>
<th>Schematic Phase</th>
<th>Design Development Phase</th>
<th>Construction Document Phase</th>
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<tbody>
<tr>
<td>Project Affected Gross Area, (GSF)</td>
<td>40,000 (See Exhibit A, 1.1)</td>
<td>40,000 (See Exhibit B, 1.1)</td>
<td>40,000 (See Exhibit C)</td>
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</table>
| Annual Building Energy Consumption  
All Energy Input Converted to BTU, (MBTU/year) | 14,518 (See Exhibit A, 1.2) | 12,781 (See Exhibit B, 1.2) | 12,781 (See Exhibit C) |
| Annual Building Energy Consumption per GSF, (BTU/year/GSF) | 363,000 (See Exhibit A, 1.3) | 319,500 (See Exhibit B, 1.3) | 319,500 (See Exhibit C) |

**Electrical:**

<table>
<thead>
<tr>
<th>Maximum Demand, (kW)</th>
<th>480 (See Exhibit A, 2.1)</th>
<th>474 (See Exhibit B, 2.1)</th>
<th>474 (See Exhibit C)</th>
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<tr>
<td>Annual Consumption, (kWH/year):</td>
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<td>786,545 (See Exhibit B, 2.2)</td>
<td>786,545 (See Exhibit C)</td>
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<td>Lighting</td>
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<td>346,080 (See Exhibit C)</td>
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<tr>
<td>Miscellaneous Power</td>
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<td>212,367 (See Exhibit B, 2.4)</td>
<td>212,367 (See Exhibit C)</td>
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<td>HVAC Equipment</td>
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<td>228,098 (See Exhibit B, 2.5)</td>
<td>228,098 (See Exhibit C)</td>
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</table>

**165 PSI Steam:**

<table>
<thead>
<tr>
<th>Peak Load, (lbs/hr):</th>
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</thead>
<tbody>
<tr>
<td>Summer</td>
<td>400 (See Exhibit A, 3.1)</td>
<td>250 (See Exhibit B, 3.1)</td>
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<tr>
<td>Winter</td>
<td>400 (See Exhibit A, 3.2)</td>
<td>250 (See Exhibit B, 3.2)</td>
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<tr>
<td>Annual Consumption, (Lb/yr)</td>
<td>200 (See Exhibit A, 3.3)</td>
<td>125 (See Exhibit B, 3.3)</td>
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</table>
### Energy Impact Statement

**Project Name:** Example Building  
**OFPC Project No.:** P1000XXX-03-001

#### Chilled Water:

<table>
<thead>
<tr>
<th></th>
<th>Schematic Phase</th>
<th>Design Development Phase</th>
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<tbody>
<tr>
<td><strong>Peak Load, (tons/hour):</strong></td>
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<tr>
<td><strong>Summer</strong></td>
<td>320</td>
<td>304</td>
<td>304</td>
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<td></td>
<td>(See Exhibit A, 4.1)</td>
<td>(See Exhibit B, 4.1)</td>
<td>(See Exhibit C)</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td>100</td>
<td>82</td>
<td>82</td>
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<tr>
<td></td>
<td>(See Exhibit A, 4.2)</td>
<td>(See Exhibit B, 4.2)</td>
<td>(See Exhibit C)</td>
</tr>
<tr>
<td><strong>Annual Consumption, (ton-hours/year)</strong></td>
<td>320,000</td>
<td>297,856</td>
<td>297,856</td>
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<td></td>
<td>(See Exhibit A, 4.3)</td>
<td>(See Exhibit B, 4.3)</td>
<td>(See Exhibit C)</td>
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</tbody>
</table>

#### Domestic Cold Water:

|                      |                |                          |                            |
| **Peak Cold Water Demand, (GPM)** | 200            | 200                      | 200                        |
|                      | (See Exhibit A, 5.1) | (See Exhibit B, 5.1)      | (See Exhibit C)            |
| **Peak Sanitary Demand, (GPM)**   | 231             | 231                      | 231                        |
|                      | (See Exhibit A, 5.2) | (See Exhibit B, 5.2)      | (See Exhibit C)            |
| **Annual Consumption (million gallons/year):** | 9.53           | 9.53                     | 9.53                       |
| Sanitary Sewer       | Not Required   | 11.53                    | 11.53                      |
|                      | (See Exhibit A, 5.3) | (See Exhibit B, 5.3)      | (See Exhibit C)            |

#### Domestic Hot Water:

|                      |                |                          |                            |
| **Peak Demand, (GPM)** | 75             | 75                       | 75                         |
|                      | (See Exhibit A, 6.1) | (See Exhibit B, 6.1)      | (See Exhibit C)            |
| **Annual Consumption, (million gallons/year)** | 3.01           | 3.01                     | 3.01                       |
|                      | (See Exhibit A, 6.2) | (See Exhibit B, 6.2)      | (See Exhibit C)            |

#### Natural Gas:

|                      |                |                          |                            |
| **Peak Demand, (CCF/hour)** | 5              | 4                        | 4                           |
|                      | (See Exhibit A, 7.1) | (See Exhibit B, 7.1)      | (See Exhibit C)            |
| **Annual Consumption, (CCF/year)** | 2,500         | 2,000                    | 2,000                      |
|                      | (See Exhibit A, 7.2) | (See Exhibit B, 7.2)      | (See Exhibit C)            |

#### Storm Drainage System:

|                      |                |                          |                            |
| **Design Storm Peak Volume, (GPM)** | 286            | 302                      | 302                        |
|                      | (See Exhibit A, 8.1) | (See Exhibit B, 8.1)      | (See Exhibit C)            |
In accordance with the Design Phase Deliverables; at the Schematic Design Phase, the design professional will have completed the following items which contribute to the development of the Energy Impact Statement:

- Reviewed energy code requirements.
- Typical building elevations with window placement.
- Roof layout.
- Typical floor plans with identified area uses and resulting area square footage.
- Identified all needed HVAC systems with one-line flow diagrams.
- Conceptual plumbing and piping layout.
- Electric one-line diagrams based on conceptual electric requirements.

### Exhibit A
Energy Impact Statement – Sample
Schematic Design Phase Calculations

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Building Energy Summary</th>
<th>Descriptions &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Project Affected Gross Area, (GSF)</td>
<td>40,000 Sq. Ft. per Schematic Design Phase Programming.</td>
</tr>
<tr>
<td>1.2</td>
<td>Annual Building Energy Consumption, (MBTU/year)</td>
<td>All Energy Input Converted to MBTU/year Electric=2,730.4 MBTU/year [See Item 2.2] Chilled Water = 3,840 MBTU/year [See Item 4.3] 165 PSI Steam=236.4 MBTU/year [See Item 3.3] Natural Gas=250.0 MBTU/year [See Item 7.2] Total All Sources=14,519 MBTU/year</td>
</tr>
<tr>
<td>1.3</td>
<td>Annual Building Energy Consumption per Sq. Ft., (BTU/year/GSF)</td>
<td>14,519 MBTU/year/40,000 SF=363,000 Btu/year/SF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Electrical</th>
<th>Descriptions &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Max Demand, (kW)</td>
<td>Assume: Lighting @ 2 Watts/SF Misc. Electric @ 5 Watts/SF HVAC @ 5 Watts/SF Results in 480 kW Peak Summer Load</td>
</tr>
<tr>
<td>2.2</td>
<td>Annual Consumption, (MWH/year)</td>
<td>Assume Annual consumption @ 20 kWH/year per SF. 20 kWH/year per SF X 40,000 SF=800,000 kWh/year.</td>
</tr>
<tr>
<td>2.3</td>
<td>Lighting</td>
<td>Breakout value not required for this item in Schematic Phase.</td>
</tr>
<tr>
<td>2.4</td>
<td>Miscellaneous Power</td>
<td>Breakout value not required for this item in Schematic Phase.</td>
</tr>
<tr>
<td>2.5</td>
<td>HVAC Equipment</td>
<td>Breakout value not required for this item in Schematic Phase.</td>
</tr>
</tbody>
</table>
## APPENDIX: ENERGY IMPACT STATEMENT - Sample

### DESIGN AND CONSTRUCTION STANDARD

<table>
<thead>
<tr>
<th>Item No.</th>
<th>165 PSI Steam</th>
<th>Description &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Summer Peak Load, (lbs/hr)</td>
<td>Four Autoclaves: Assume 4 X 100 lbs/hour of 165 PSI steam required = 400 lbs/hour.</td>
</tr>
<tr>
<td>3.2</td>
<td>Winter Peak Load, (lbs/hr)</td>
<td>Same as Summer Peak Load = 400 lb/hr.</td>
</tr>
<tr>
<td>3.3</td>
<td>Annual Consumption, (Lb/yr)</td>
<td>Four Autoclaves: Assume 4 X 100 lbs/hour of 165 PSI steam required / 1000 lbs/hour per Lb/hr X 2 cycles/day X 250 days/yr = 200 Lb/year</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Chilled Water</th>
<th>Description &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Summer Peak Load, (tons/hr)</td>
<td>Cooling load assumed to be 125 SF/ton @ 40,000 SF = 320 tons/hr.</td>
</tr>
<tr>
<td>4.2</td>
<td>Winter Peak Load, (tons/hr)</td>
<td>Assume winter peak load for computer server rooms and miscellaneous year-round cooling needs at 100 tons.</td>
</tr>
</tbody>
</table>
### Item No. | Domestic Cold Water | Descriptions & Calculations
--- | --- | ---
5.1 Peak Demand, (GPM) | Based on a review of the International Building Code, 2000 and International Plumbing Code, 2000 to determine maximum building occupancy levels and resulting minimum number of plumbing facilities, as well as a review of similar building types on campus, it was determined that the domestic cold water peak demand be based on 750 fixture units. From Table E102 of the International Plumbing Code, 2000, the resulting domestic cold water peak demand is 177 GPM. Total DCW Peak Demand = 177 GPM. |  
5.2 Peak Sanitary Demand, (GPM) | Peak Sanitary Demand = Domestic Cold Water Demand [Item 5.1] + Domestic Hot Water Demand [Item 6.1] = 177 + 75 = 252 GPM. |  
5.3 Annual Consumption, (gallons/year): Occupied DCW: 177 GPM X 25 % Diversity X 2,000 hours/year = 5.31 million gallons/year. Unoccupied DCW: 177 GPM X 2.5% Diversity X 6,760 hours/year = 1.80 million gallons/year. Total = 5.31 + 1.80 = 7.11 million gallons/year. |  
5.4 Sanitary Sewer | *Breakout value not required for this item in Schematic Phase.* |
### Domestic Hot Water

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Peak Demand, (GPM)</td>
<td>Based on a review of the International Building Code, 2000 and International Plumbing Code, 2000 to determine maximum building occupancy levels and resulting minimum number of plumbing facilities, as well as a review of similar building types on campus, it was determined that the domestic hot water peak demand be based on 250 fixture units. From Table E102 of the International Plumbing Code, 2000, the resulting domestic hot water peak demand is 75 GPM.</td>
</tr>
<tr>
<td>6.2</td>
<td>Annual Consumption (million gallons/year): Occupied: 75 GPM X 25% Diversity X 2,000 hours/year = 2.25 million gallons/year. Unoccupied: 75 GPM X 2.5% Diversity X 6,760 hours/years = 0.76 million gallons/year. Total = 2.25 + 0.76 = 3.01 million gallons/year.</td>
<td></td>
</tr>
</tbody>
</table>

### Natural Gas

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Peak Demand, (CCF/hour)</td>
<td>Two Gas Fired Unit Heaters in Loading Dock: Assume 2 X 250,000 BTU/hr = 500,000 BTU/hr/100,000 BTU/CCF = 5 CCF/hour.</td>
</tr>
<tr>
<td>7.2</td>
<td>Annual Consumption, (CCF/year):</td>
<td>Two Gas Fired Unit Heaters in Loading Dock: Assume 2 X 250,000 BTU/hr X 2000 hours/year operation x 25% diversity/100,000 BTU/CCF = 2,500 CCF/year.</td>
</tr>
</tbody>
</table>

### Storm Drainage System

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Design Peak Storm Volume, (GPM)</td>
<td>From 2000 International Plumbing Code, Section 1106: Assume roof area of 10,000 SF @ 2.75 inches/hr (100 year rainfall) = 286 GPM.</td>
</tr>
</tbody>
</table>
Exhibit B
Energy Impact Statement—Sample
Design Development Phase Calculations

In accordance with the Design Phase Deliverables; at the Design Development Phase, the design professional will have completed the following items (in addition to those completed during the Schematic Design Phase) which contribute to the further refinement of the Energy Impact Statement:

- All building elevations with window placement and wall sections.
- Roof and drainage plan.
- All floor plans with identified area uses and resulting area square footage.
- Design criteria for each mechanical system.
- Equipment schedules for major mechanical items.
- Overall building airflow diagram.
- Conceptual control diagrams for all mechanical and plumbing systems.
- Preliminary calculations for HVAC systems.
- Design criteria for each plumbing system, including set points, etc.
- One-line diagrams for all plumbing systems.
- Plumbing and piping plans.
- Typical lighting plans.
- Lighting fixture schedule.
- Review of lighting energy code requirements.
- Normal power riser diagram.
- Power panel schedules.
- Electric load estimates.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Building Energy Summary</th>
<th>Descriptions &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Project Affected Gross Area, (GSF)</td>
<td>40,000 GSF per Design Development Phase Space Programming.</td>
</tr>
<tr>
<td>1.2</td>
<td>Annual Building Energy Consumption, (MBTU/year)</td>
<td>All Energy Input Converted to MBTU/year: Electric = 2,684 MBTU/year [See Item 2.2]; Chilled Water = 3,574.2 MBTU/year [See Item 4.3]; 165 PSI Steam = 148 MBTU/year [See Item 3.3]; Natural Gas = 200 MBTU/year [See Item 7.2]; Total All Sources = 12,781 MBTU/year</td>
</tr>
<tr>
<td>1.3</td>
<td>Annual Building Energy Consumption per GSF, (BTU/year/GSF)</td>
<td>12,781 MBTU/year/40,000 GSF = 319,522 kBtu/year/GSF</td>
</tr>
</tbody>
</table>
6.01.41 – APPENDIX: ENERGY IMPACT STATEMENT - Sample
DESIGN AND CONSTRUCTION STANDARD

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Electrical</th>
<th>Descriptions &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Maximum Demand, (kW)</td>
<td>Data from Design Development Phase lighting and power panel schedules was input into a computer simulation program. See Table B.1, “Billing Details – Electric” for maximum electric demand.  &lt;br&gt;  The maximum electric demand of 474 kW occurs in June.</td>
</tr>
<tr>
<td>2.2</td>
<td>Annual Consumption, (MWH/year)</td>
<td>Data from Design Development Phase lighting and power panel schedules was input into a computer simulation program. See Table B.1, “Billing Details—Electric” for annual electric consumption.  &lt;br&gt;  The annual electric consumption for all components is 786,545 kWh.</td>
</tr>
<tr>
<td>2.3</td>
<td>Lighting</td>
<td>For electrical consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows electrical energy as kBTUs. The estimated annual electrical consumption for lighting is listed under “Site Energy” as 1,181,170 kBTU per year. This converts to 346,080 kWh per year.</td>
</tr>
<tr>
<td>2.4</td>
<td>Miscellaneous Power</td>
<td>For electrical consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows electrical energy as kBTUs. The estimated annual electrical consumption for miscellaneous power is listed under “Site Energy” as 724,809. This converts to 212,367 kWh per year.</td>
</tr>
<tr>
<td>2.5</td>
<td>HVAC Equipment</td>
<td>For electrical consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows electrical energy as KBTUs. The estimated annual electrical consumption for HVAC is listed under “Site Energy” as the sum of the air system fans, pumps and cooling towers, or 536,896 + 53,690 + 187,913 = 778,499. This sum converts to 228,098 kWh per year.</td>
</tr>
</tbody>
</table>
## 6.01.41 – APPENDIX: ENERGY IMPACT STATEMENT - Sample
### DESIGN AND CONSTRUCTION STANDARD

### 165 PSI Steam

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td><strong>Summer Peak Load, (lbs/hr)</strong> During the Design Development Phase two autoclaves were eliminated. From the equipment schedules, the two remaining autoclaves require 125 lbs/hour. 2 X 125 lbs/hour of 165 PSI steam required = 250 lbs/hour.</td>
</tr>
<tr>
<td>3.2</td>
<td><strong>Winter Peak Load, (lbs/hr)</strong> Same as Summer Peak Load = 250 lbs/hr.</td>
</tr>
<tr>
<td>3.3</td>
<td><strong>Annual Consumption, (Lb/yr)</strong> Assume 2 X 125 lbs/hour of 165 PSI steam required / 1000 lbs/hour per Lb/hr X 2 cycles/day X 250 days/yr = 125 Lb/year</td>
</tr>
</tbody>
</table>

### Chilled Water

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td><strong>Summer Peak Load, (tons/hr)</strong> Data from Design Development Phase was input into a computer simulation program to determine the estimated peak chilled water demand. See Table B.3, “Hourly Simulation – Summer Chiller Plant” for details. The peak summer chilled water demand of 3,648 MBH or 304 tons occurs at 4:00 pm on July 22.</td>
</tr>
<tr>
<td>4.2</td>
<td><strong>Winter Peak Load, (tons/hr)</strong> Data from Design Development Phase was input into a computer simulation program to determine the estimated peak chilled water demand. See Table B.4, “Hourly Simulation – Winter Chiller Plant” for details. The peak winter chilled water demand of 984 MBH or 82 tons occurs at 2:00 pm on April 28.</td>
</tr>
<tr>
<td>4.3</td>
<td><strong>Annual Consumption, (ton-hrs/yr)</strong> Data from Design Development Phase was input into a computer simulation program to determine the annual chilled water consumption. See Table B.2, “Energy Budget by System Component” for details. The estimated annual chilled water consumption is listed under “Site Energy” as 3,574,272 kBTU. This converts to 297,856 ton-hours per year. Note: winter cooling load is handled by winterized cooling towers via free cooling system.</td>
</tr>
<tr>
<td>Item No.</td>
<td>Domestic Cold Water</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------</td>
</tr>
<tr>
<td>5.1</td>
<td>Peak Demand, (GPM)</td>
</tr>
<tr>
<td>5.2</td>
<td>Peak Sanitary Demand, (GPM)</td>
</tr>
<tr>
<td>5.3</td>
<td>Annual Consumption, (million gallons/year):</td>
</tr>
<tr>
<td>5.4</td>
<td>Annual Sanitary Sewer, (million gallons/year)</td>
</tr>
</tbody>
</table>
### Domestic Hot Water

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Peak Demand, (GPM)</td>
</tr>
<tr>
<td></td>
<td>Based on a review of the International Building Code, 2000 and International Plumbing Code, 2000 to determine maximum building occupancy levels and resulting minimum number of plumbing facilities, as well as a review of similar building types on campus, it was determined that the domestic hot water peak demand be based on 250 fixture units. From Table E102 of the International Plumbing Code, 2000, the resulting domestic hot water peak demand is 75 GPM.</td>
</tr>
<tr>
<td>6.2</td>
<td>Annual Consumption, (million gallons/year):</td>
</tr>
<tr>
<td></td>
<td>Occupied: 75 GPM X 25% Diversity X 2,000 hours/year = 2.25 million gallons/year. Unoccupied: 75 GPM X 2.5% Diversity X 6,760 hours/year = 0.76 million gallons/year. Total=2.25 + 0.76 = 3.01 million gallons/year.</td>
</tr>
</tbody>
</table>

### Natural Gas

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Peak Demand, (CCF/hour)</td>
</tr>
<tr>
<td></td>
<td>Two Gas Fired Unit Heaters in Loading Dock: From the Design Development Phase mechanical equipment schedules, the two gas fired unit heaters were downsized two at 200,000 BTU/hr each. 2 X 200,000 BTU/hr = 400,000 BTU/hr/100,000 BTU/CCF = 4 CCF/hour.</td>
</tr>
<tr>
<td>7.2</td>
<td>Annual Consumption, (CCF/year):</td>
</tr>
<tr>
<td></td>
<td>Two Gas Fired Unit Heaters in Loading Dock: Assume 2 X 200,000 BTU/hr X 2000 hours/year operation x 25% diversity/100,000 BTU/CCF=2,000 CCF/year.</td>
</tr>
</tbody>
</table>

### Storm Drainage System

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description &amp; Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Design Peak Storm Volume, (GPM)</td>
</tr>
<tr>
<td></td>
<td>Roof area from Design Development Phase Roof Plan is 10,560 SF. From 2000 International Plumbing Code, Section 1106: 10,560 SF @ 2.75 inches/hr (100 year rainfall) = 302 GPM.</td>
</tr>
</tbody>
</table>
Exhibit C
Energy Impact Statement – Sample
Construction Document Phase Calculations

In accordance with the Design Phase Deliverables; at the Construction Document Phase, the
design professional will have completed the following items (in addition to those completed
during the Design Development Phase) which contribute to the further refinement of the
Energy Impact Statement:

- Complete specification.
- One-line diagrams for all mechanical systems.
- Duct layout and air flow volumes for each space.
- Detailed control drawings with sequences of operation.
- All design calculations.
- Lighting plans for all areas.
- Electrical power load summary.
- Electrical panel schedules.

Because the majority of the information needed for accurate estimates in the Energy Impact
Statement is available in the Design Development Phase, most projects will require very little
Also, there is no change in the methodology used to determine estimates in moving form the
Design Development Phase to the Construction Document Phase.

For these reasons, it is assumed that (for this example) there is no change in the Energy Impact
Statement. Estimates shown in the Design Development Phase column of the Energy Impact
Statement are repeated in the Construction Document Phase column.

It is not unusual for projects to change significantly in moving from Design Development Phase
to Construction Document Phase (usually due to budget constraints). In these cases there may be
significant changes to the Energy Impact Statement which the design professional will be
expected to document.
### 1.1 PIPE PRESSURE TESTS:

A. The following lines shall be tested at the stated pressure for the length of time noted. Pressure gauges used should have a range no greater than 50% over test pressure. The values below are guidelines. Codes and field conditions will be used by the PSP to verify the validity of numbers below.

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>MEDIUM</th>
<th>TESTING PRESSURE</th>
<th>TESTING TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water</td>
<td>Water</td>
<td>125***</td>
<td>2 hours</td>
</tr>
<tr>
<td>Steam (Low pressure &amp; steam condensate)</td>
<td>Water</td>
<td>60</td>
<td>2 hours</td>
</tr>
<tr>
<td>High-Pressure Steam</td>
<td>Lab Water</td>
<td>225</td>
<td>2 hours</td>
</tr>
<tr>
<td>Domestic Hot &amp; Cold Water*</td>
<td>Water</td>
<td>125</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Low Pressure Natural Gas</td>
<td>Air</td>
<td>30</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Medium Pressure Natural Gas</td>
<td>Air</td>
<td>60</td>
<td>2 hours</td>
</tr>
<tr>
<td>Sanitary, Storm, Waste, Vent</td>
<td>Water, 10 foot head</td>
<td>24 hours</td>
<td></td>
</tr>
<tr>
<td>Or</td>
<td>Air</td>
<td>5</td>
<td>2 hours</td>
</tr>
<tr>
<td>Piped Vacuum System</td>
<td>Nitrogen</td>
<td>60</td>
<td>2 hours</td>
</tr>
<tr>
<td>Compressed Air*</td>
<td>Air</td>
<td>125</td>
<td>2 hours</td>
</tr>
<tr>
<td>D I Water (Lab Water)</td>
<td>Water</td>
<td>60*</td>
<td>2 hours</td>
</tr>
<tr>
<td>Medical Gasses*</td>
<td>Nitrogen</td>
<td>150</td>
<td>24 hours</td>
</tr>
<tr>
<td>Sprinkler and Fire System Main</td>
<td>Water</td>
<td>200</td>
<td>2 hours</td>
</tr>
<tr>
<td>Dry Pipe Fire System</td>
<td>Water</td>
<td>200</td>
<td>24 hours</td>
</tr>
</tbody>
</table>

* Or 150% of Working Pressure; whichever is greater  
** Welded Steel pipe (Adopted 4/27/2007)  
*** Main chilled water loop testing pressure 150% of design pressure, minimum test pressure 225 psig  

NOTE: Use of air or nitrogen as the testing medium shall require specific testing procedures due to the high hazard potential.
6.02.20 – APPENDIX: WATER RECOVERY AND RE-USE
DESIGN AND CONSTRUCTION STANDARD

1.01 RECOVERED WATER

A. The University of Texas main campus maintains a system of pipelines in the utility tunnels that collect clean water from buildings and deliver it to the cooling towers of our power plant and chilling stations. The sources of this water are Fin Water (condensation water that drips off the fins of cooling coils in HVAC systems), ground water (from French drains and basement sumps), once-through cooling systems of laboratory equipment (where the water originated from the domestic water system and would otherwise be dumped to sanitary sewer; the practice of once-through cooling was previously used extensively, but now should be avoided unless absolutely necessary due to the high cost per gallon of City water.) and, occasionally, swimming pool drain water.

B. Most of the tunnel pipelines for Recovered Water are 4-inch and 6-inch. Utilities maintains a pressure of about 60 psig, referenced to the surface elevation of Speedway at 24th St.

C. Recovered water used to come in two varieties, Domestic Recovered Water and Non-Domestic Recovered Water, but now the two sources are mixed so there is no longer a distinction. Some tunnels continue to have separate pipelines for the two.

D. Recovered Water is NOT carried in purple-colored pipe. Recovered Water pipe is usually white or gray PVC, or galvanized with Victaulic couplings. Recovered Water piping is usually located in utility tunnels.

E. Distinctions between different types of recovered water:
   1. Fin water: AC condensate. It’s not steam condensate, which is why it is called “fin water”. It’s very clean from a water chemistry standpoint; sometimes it is fouled by bacteria or algae growing in the AHUs.
   2. Ground water: is typically in the range of 300 to 600 microSiemens/cm. Can cause scaling of pipes over time so no piping should be installed smaller than 2” at connections to sources, 4 to 6 inch, even 8 inch pipe in the tunnels.
   3. Once-through cooling (city water): Have the same water quality characteristics as regular city water. This cooling method should be avoided in favor of a dedicated closed-loop system due to the high cost per gallon of City water (it is also a violation of the City’s plumbing code).
   4. Swimming pool drain water: is the fourth type of recovered water. It is similar to city water in quality, modified by halogenic disinfection by-products, free chlorine, and chloramines.
   5. All these sources are mixed into the same distribution piping in the tunnels.

1.02 RECLAIMED (RE-USE) WATER

A. The campus has several thousand feet of purple pipe installed, ready to carry Reclaimed Water. The City of Austin extended their Reclaimed Water piping to the campus in 2010 and Utilities and Energy Management is working on projects to connect to the city system and use the water for cooling tower makeup.

B. Reclaimed Water is highly treated wastewater from the City wastewater treatment plants. The City will sell Reclaimed Water at a discounted price, and UT intends to use it for cooling tower makeup. We have been advised that its higher nitrogen content makes it unsuitable for decorative fountains. Reclaimed Water pipe is direct buried, like domestic water piping and unlike Recovered Water piping.

1.03 IRRIGATION WATER

A. Irrigation Water is 100% identical to City of Austin domestic water. It comes out of the same City of Austin water mains. The only distinction between Irrigation Water and Domestic Water is that
Irrigation Water carries no wastewater charge, so it can only be used for irrigation or for cooling tower makeup when the cooling tower blow-down is metered and billed separately. It also is not backflow protected and is therefore not suitable as a source of drinking water.

1.04 DOMESTIC WATER

A. This is potable water from the City of Austin, used for drinking, hand-washing, bathing, etc. It is the most expensive source of "wetness," so use the alternatives listed above whenever possible. UT has its own network of buried domestic water mains under much of the campus, supplied from multiple City water meters which are tapped into City-owned buried domestic water mains.

1.05 STANDARDS

A. All source connections should be hard-plumbed to prevent introduction of oil, solvents, trash, etc., into system. (See attached standard for fin water connections to AHUs, for example).

B. We want valves (bronze gate for sizes 4" and larger- because the big PVC ball valves tend to "seize up" and break in larger sizes and PVC ball valves for under 4") at all sides of a tee connection.

C. Receivers are Aurora Series 222 Duplex units, or Flygt submersibles for ground water sumps. Provide pipe-size strainers with stainless steel screens and blow-down valves in an accessible location in the discharge piping near any pump.

D. Provide 2" drains with 2" PVC ball valves every 50 feet in the tunnels for new runs.

E. No check valves anywhere in the bi-directional tunnel mains.

F. Tunnel mains and smaller service laterals from sources should be PVC schedule 80, except copper is acceptable anywhere.

G. Provide pipe labels to say "Recovered Water every 50 feet in the mains; fin water piping should be labeled "Fin Water" every 50 feet until it joins a source that is not fin water (e.g., once through recovery).

END OF STANDARD
# 6.03.10 APPENDIX - TYPICAL I/O POINTS SCHEDULE
## DESIGN AND CONSTRUCTION STANDARD

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<th>ANALOG INPUT</th>
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**Air Flow**

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**Smoke Management**

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**Notes:**

1. List is not all inclusive, and is intended to convey representative sample points list for a typical project. Engineer responsible to develop project specific points list required for control, supervision, and interoperability of equipment and systems consistent with Owner's requirements.
2. List does not include software alarms based on analog inputs.
3. List does not include system setpoints.
The following appendix section will be included as part of the contract with the Professional Service Provider (PSP) for design services:

Supplemental Conditions to the Contract with PSP for Design Services

The Professional Service Provider (PSP) is required to incorporate the procedures and minimum requirements outlined in The University of Texas at Austin Design & Construction Standards. The Standards are intended to provide useful information to the PSP with regard to establishing minimum requirements for the design—including the establishment of energy efficiency and sustainability project goals. The responsibility of the PSP is to apply these Standards such that the University may achieve a common basis for the design, construction, maintenance, renovation and general care of facilities.

It is the responsibility of the PSP to request a copy of the most current Standards. It should be clearly understood by all persons using these Standards that they are not specification documents, nor are they procedures for construction. Design and document preparation continue to be the PSP’s responsibility. Means, methods, techniques, and procedures remain the Contractor’s responsibility.

These Standards represent the preferred construction products, materials, details and systems to use in the development of programs, plans, specifications and construction documents for UT Austin projects. Components shall be selected through pre-qualification guidelines including, but not necessarily limited to, performance characteristics, code/regulatory compliance, maintenance control, and inventory standardization. These Standards represent the intent of the University to address the following primary criteria while providing optimal life cycle cost benefit to the University:

1) Safety
2) Reliability
3) Maintainability
4) Efficiency
5) Sustainability

These standards are not intended to limit creative solutions. The University will consider requests for substitutions or variances in order to provide the best benefit to the University and will typically require a life cycle cost analysis to be completed as part of the substitution or variance process as outlined in the Standards. When the Standards refer to a single manufacturer, it is not intended to exclude all other alternatives for all projects, unless explicitly stated.