

# Facility Design Guidelines



The Texas A&M University System  
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## Table of Contents

|  | Page |
|--|------|
| <b>Introduction</b>                                |      |
| Historically Underutilized Business Program        | ii-1 |
| General Information                                | ii-1 |
| <b>Design Criteria</b>                             |      |
| General Information                                |      |
| Design Philosophy                                  | A-1  |
| Design Quality                                     |      |
| Campus Design Standards                            |      |
| Operating & Building Maintenance                   |      |
| Sustainability and Energy Performance              |      |
| Codes and Standards                                | A-2  |
| General Requirements                               |      |
| Design Basis                                       |      |
| Architectural Design                               |      |
| Civil/Structural Design                            |      |
| Mechanical and Plumbing Design                     |      |
| Electrical Design                                  |      |
| Communications Design                              |      |
| Energy and Water Conservation Design               |      |
| Acoustic Design                                    |      |
| Environmental Practices                            | A-6  |
| Sustainable Design                                 |      |
| Energy Performance                                 |      |
| Daylighting  |      |
| Building Materials                                 |      |
| Indoor Air Quality                                 |      |
| Commissioning                                      | A-7  |
| Life Cycle Costing                                 | A-8  |
| Space Standards                                    | A-11 |
| Calculation of Building Areas                      |      |
| Building Core Elements                             | A-12 |
| First Floor Elevation                              |      |
| Building Entrances                                 |      |
| Building Circulation                               |      |
| Crawl Space Under Suspended Structural Foundations |      |
| Egress Stairs                                      |      |
| Equipment Rooms                                    |      |

## Table of Contents

|  |      |
|--|------|
| Electrical Closets   |      |
| Main Switchgear Room   |      |
| Communications Closet  |      |
| Air Handler Rooms  |      |
| Rest Rooms   |      |
| Loading Docks  |      |
| Trash Dumpsters  |      |
| Recycling Rooms  |      |
| Custodial Closets  |      |
| Server Room Requirements                                       |      |
| Floor and Space Identification Systems on Drawings             | A-18 |
| Assignment of Floor Numbers                                    |      |
| Assignment of Room Numbers                                     |      |
| <b>Campus Specific Information</b>                             |      |
| Texas A&M University   | A-19 |
| Energy Performance   |      |
| Commissioning  |      |
| Family Rooms   |      |
| Maintenance Service Area                                       |      |
| Vending Standards  |      |
| West Texas A&M University                                      | A-29 |
| Main Switchgear Room   |      |
| Maintenance Service Area                                       |      |
| Vending Standards  |      |
| Texas A&M University-Texarkana                                 | A-21 |
| Maintenance Service Area                                       |      |
| Vending Standards  |      |
| <b>Division 0 – Procurement &amp; Contracting Requirements</b> |      |
| General Information  |      |
| <b>Division 1 – General Requirements</b>                       |      |
| General Information  |      |

## Table of Contents

### Division 2 – Existing Conditions

#### General Information

|                                |     |
|--------------------------------|-----|
| Survey                         | 2-1 |
| Hazardous Materials Assessment | 2-2 |
| Geotechnical Investigations    | 2-3 |
| Demolition                     | 2-5 |
| Tree Protection                | 2-6 |

### Division 3 – Concrete

#### General Information

|  |     |
|--|-----|
| Concrete   | 3-1 |
| Void Space Below Grade Beams                       | 3-1 |
| General Floor Loading                              | 3-1 |
| Porches and Steps                                  | 3-2 |
| Cement Finished Floors                             | 3-2 |
| Crawl Space Under Suspended Structural Foundations | 3-2 |
| Concrete Reinforcing                               | 3-2 |
| Precast, Tilt-up and/or Special Finished Concrete  | 3-2 |
| Roof Decks   | 3-2 |
| Mow Strips   | 3-3 |

### Division 4 – Masonry

#### General Information

|                           |     |
|---------------------------|-----|
| Brick                     | 4-1 |
| Brick Selection Procedure | 4-1 |
| Concrete Masonry Units    | 4-1 |
| Stone                     | 4-1 |
| Overhung Masonry          | 4-2 |
| Masonry Accessories       | 4-2 |

#### Campus Specific Information

|                           |     |
|---------------------------|-----|
| Texas A&M University      | 4-2 |
| Brick                     |     |
| Cut Stone                 |     |
| Cast Stone                |     |
| Tarleton State University | 4-3 |

## Table of Contents

|                                     |     |
|-------------------------------------|-----|
| Brick                               |     |
| Prairie View A&M University         | 4-3 |
| Brick                               |     |
| Texas A&M University at Galveston   | 4-3 |
| Brick                               |     |
| Texas A&M University-Corpus Christi | 4-3 |
| Brick                               |     |
| Texas A&M International University  | 4-3 |
| Brick                               |     |
| Cut Stone                           |     |
| Texas A&M University-Kingsville     | 4-4 |
| Brick                               |     |
| West Texas A&M University           | 4-4 |
| Brick                               |     |
| Texas A&M University-Commerce       | 4-4 |
| Brick                               |     |
| Texas A&M University-Texarkana      | 4-4 |
| Brick                               |     |

### Division 5 – Metals

#### General Information

|                              |     |
|------------------------------|-----|
| Structural Steel             | 5-1 |
| Cold-Formed Metal Framing    | 5-1 |
| Metal Fabrications           | 5-1 |
| Metal Stairs                 | 5-1 |
| Lightning Protection Systems | 5-1 |

#### Campus Specific Information

|                                     |     |
|-------------------------------------|-----|
| Texas A&M University at Galveston   | 5-1 |
| Texas A&M University-Corpus Christi |     |

### Division 6 – Wood, Plastics and Composites

#### General Information

|                             |     |
|-----------------------------|-----|
| Wood Treatment              | 6-1 |
| Sheathing                   | 6-1 |
| Finish Carpentry            | 6-1 |
| Millwork                    | 6-1 |
| Architectural Wood Casework | 6-1 |

# Table of Contents

## Division 7 – Thermal and Moisture Protection

### General Information

|                     |     |
|---------------------|-----|
| Building Insulation | 7-1 |
| Roofing             | 7-1 |

### Campus Specific Information

|                                     |     |
|-------------------------------------|-----|
| Texas A&M University                | 7-2 |
| Tarleton State University           | 7-3 |
| Prairie View A&M University         | 7-3 |
| Texas A&M University at Galveston   | 7-3 |
| Texas A&M University-Corpus Christi | 7-3 |
| Texas A&M International University  | 7-3 |
| Texas A&M University-Kingsville     | 7-3 |
| West Texas A&M University           | 7-3 |
| Texas A&M University-Commerce       | 7-3 |
| Texas A&M University-Texarkana      | 7-4 |

### Guide Specification

|   |      |
|---|------|
| Urethane Foam Roof System                       | 7-5  |
| Coal-Tar Elastomeric Membrane Multi-Ply Roofing | 7-13 |
| Application for Acceptance of Roofing System    | 7-18 |

## Division 8 – Openings

### General Information

|   |     |
|---|-----|
| Doors and Frames                        | 8-2 |
| Entrances, Storefronts and Curtainwalls | 8-2 |
| Windows                                 | 8-3 |
| Hardware                                | 8-3 |
| Glazing                                 | 8-4 |

### Campus Specific Information

|                                       |     |
|---------------------------------------|-----|
| Texas A&M University<br>Hardware      | 8-5 |
| Tarleton State University<br>Hardware | 8-7 |
| Prairie View A&M University           | 8-7 |

## Table of Contents

|                                     |      |
|-------------------------------------|------|
| Hardware                            |      |
| Texas A&M University at Galveston   | 8-8  |
| Hardware                            |      |
| Texas A&M University-Corpus Christi | 8-8  |
| Hardware                            |      |
| Texas A&M International University  | 8-9  |
| Hardware                            |      |
| Texas A&M University-Kingsville     | 8-10 |
| Hardware                            |      |
| West Texas A&M University           | 8-10 |
| Hardware                            |      |
| Texas A&M University-Commerce       | 8-11 |
| Hardware                            |      |
| Texas A&M University-Texarkana      | 8-12 |
| Hardware                            |      |

### Division 9 - Finishes

#### General Information

|                               |     |
|-------------------------------|-----|
| Gypsum Wallboard              | 9-1 |
| Tile                          | 9-1 |
| Suspended Acoustical Ceilings | 9-1 |
| Terrazzo                      | 9-2 |
| Carpet Systems                | 9-3 |
| Resilient Tile Flooring       | 9-3 |
| Vinyl Wall Covering           | 9-3 |
| Painting and Coating          | 9-3 |

#### Campus Specific Information

|                                     |     |
|-------------------------------------|-----|
| Texas A&M University                | 9-4 |
| Resilient Tile Flooring             |     |
| Texas A&M University-Corpus Christi | 9-5 |
| Gypsum Wallboard                    |     |
| West Texas A&M University           | 9-5 |
| Carpet Systems                      |     |
| Resilient Tile Flooring             |     |
| Painting and Coating                |     |
| Texas A&M University-Texarkana      | 9-7 |
| Resilient Tile Flooring             |     |
| Gypsum Wallboard                    |     |



## Table of Contents

### Guide Specification

|                |     |
|----------------|-----|
| Carpet Systems | 9-9 |
|----------------|-----|

### Division 10 – Specialties

#### General Information

|                                 |      |
|---------------------------------|------|
| Directories                     | 10-1 |
| Graphics                        | 10-1 |
| Toilet Partitions               | 10-1 |
| Corner Guards and Rails         | 10-1 |
| Toilet Accessories              | 10-1 |
| Fire Extinguishers and Cabinets | 10-2 |

#### Campus Specific Information

|                                     |      |
|-------------------------------------|------|
| Texas A&M University                | 10-2 |
| Rest Room Requirements              |      |
| Fire Extinguishers                  |      |
| Tarleton State University           | 10-3 |
| Rest Room Requirements              |      |
| Texas A&M University-Corpus Christi | 10-4 |
| Rest Room Requirements              |      |
| Texas A&M University-Kingsville     | 10-4 |
| Rest Room Requirements              |      |
| West Texas A&M University           | 10-5 |
| Rest Room Requirements              |      |
| Fire Extinguishers                  |      |
| Texas A&M University-Commerce       | 10-6 |
| Rest Room Requirements              |      |

### Division 11 – Equipment

#### General Information

|                        |      |
|------------------------|------|
| Audio-Visual Equipment | 11-1 |
| Laboratory Equipment   | 11-1 |

#### Campus Specific Information

|                      |      |
|----------------------|------|
| Texas A&M University | 11-5 |
| Special Hoods        |      |

## Table of Contents

### Division 12 – Furnishings

#### General Information

|                     |      |
|---------------------|------|
| Window Treatments   | 12-1 |
| Laboratory Casework | 12-1 |
| Book Shelves        | 12-1 |
| Furniture Selection | 12-1 |
| Fixed Seating       | 12-1 |

### Division 13 – Special Construction

#### General Information

|                              |      |
|------------------------------|------|
| Controlled Environment Rooms | 13-1 |
|------------------------------|------|

### Division 14 – Conveying Equipment

#### General Information

|  |      |
|--|------|
| Elevators                              | 14-1 |
| Passenger Elevators                    | 14-2 |
| Combination Passenger/Service Elevator | 14-4 |
| Freight Elevators                      | 14-4 |

#### Campus Specific Information

|   |      |
|---|------|
| Texas A&M University<br>Elevator Requirements | 14-5 |
|---|------|

### Division 21 - Fire Suppression

#### General Information

|                          |      |
|--------------------------|------|
| Fire Suppression Systems | 21-1 |
| Special Systems          | 21-4 |

#### Campus Specific Information

|  |      |
|--|------|
| Texas A&M University<br>Fire Department Lock Box<br>Fire Department Connection<br>Fire Suppression Systems | 21-5 |
| West Texas A&M University  | 21-6 |

## Table of Contents

### Fire Protection Piping

#### Division 22 - Plumbing

##### General Information

|                            |      |
|----------------------------|------|
| Metering                   | 22-2 |
| Piping                     | 22-2 |
| Plumbing                   | 22-3 |
| Mechanical Equipment Rooms | 22-4 |
| Rest Rooms                 | 22-4 |

##### Campus Specific Information

|                           |      |
|---------------------------|------|
| Texas A&M University      | 22-5 |
| Metering                  |      |
| West Texas A&M University | 22-5 |

#### Division 23 - Heating, Ventilating and Air Conditioning

##### General Information

|                                   |       |
|-----------------------------------|-------|
| Ductwork                          | 23-2  |
| Metering                          | 23-3  |
| Piping                            | 23-3  |
| Mechanical Equipment Rooms        | 23-4  |
| Flow Diagrams                     | 23-5  |
| Space Conditioning                | 23-5  |
| Ventilation                       | 23-6  |
| Laboratory Design                 | 23-6  |
| Acoustics                         | 23-7  |
| Calculations for HVAC Design      | 23-7  |
| Mechanical and Electrical General | 23-8  |
| Design Conditions                 | 23-9  |
| Boilers                           | 23-10 |
| Hydronic Pipe Cleaning Guidelines | 23-10 |

##### Campus Specific Information

|   |       |
|---|-------|
| Texas A&M University                                    | 23-11 |
| Chilled Water (CHW) and Heating Hot Water (HHW) Systems |       |
| Metering  |       |
| Central Plant Utility Systems                           |       |
| Prairie View A&M University                             | 23-16 |

## Table of Contents

|  |       |
|--|-------|
| Central Plant Utility Systems                                |       |
| Tarleton State University                                    | 23-17 |
| Central Plant Utility Systems                                |       |
| Texas A&M University at Galveston                            | 23-18 |
| Central Plant Utility Systems                                |       |
| West Texas A&M University                                    | 23-19 |
| Chilled Water Piping   |       |
| Heating Water Piping   |       |
| Medium and High Pressure Steam Piping                        |       |
| Low Pressure Steam Piping                                    |       |
| Medium and High Pressure Steam Condensate Piping             |       |
| Low Pressure Steam Condensate Piping                         |       |
| <br>Guide Specification                                      |       |
| Air Handling Units for Design & Construction                 | 23-21 |
| Variable Air Volume Terminal Units for Design & Construction | 23-24 |
| <br><b>Division 25 - Integrated Automation</b>               |       |
| <br>General Information                                      |       |
| Automatic Temperature Controls                               | 25-1  |
| Energy Management System                                     | 25-1  |
| <br>Campus Specific Information                              |       |
| Texas A&M University   | 25-1  |
| Tarleton State University                                    | 25-1  |
| Prairie View A&M University                                  | 25-1  |
| Texas A&M University at Galveston                            | 25-1  |
| Texas A&M University-Corpus Christi                          | 25-2  |
| Texas A&M International University                           | 25-2  |
| Texas A&M University-Kingsville                              | 25-2  |
| West Texas A&M University                                    | 25-2  |
| Texas A&M University-Commerce                                | 25-2  |
| Texas A&M University-Texarkana                               | 25-2  |
| Baylor College of Dentistry                                  | 25-2  |

# Table of Contents

## Guide Specification

|  |       |
|--|-------|
| Automatic Temperature Controls & Energy Management Systems                             | 25-3  |
| Automatic Temperature Controls & Energy Management Systems<br>For Texas A&M University | 25-16 |

## Division 26 - Electrical

### General Information

|  |       |
|--|-------|
| Purpose and Application of this Division         | 26-1  |
| Electrical Codes and Standards                   | 26-1  |
| Overview   |       |
| Codes & Standards Applicable to this Division    |       |
| Fundamental System Requirements                  | 26-5  |
| Adequacy and Future Expansion                    |       |
| Fault Current Capacity                           |       |
| Facility Lightning Protection                    |       |
| Power Quality                                    |       |
| Power System Harmonic Limits                     |       |
| Power System Reliability                         |       |
| Overcurrent Protection                           |       |
| Standards for Material & Equipment               |       |
| Personnel Safety                                 |       |
| Locating Electrical Equipment                    |       |
| Identifying Electrical Equipment                 |       |
| Overview   |       |
| Arc-Flash & Shock-Hazard Warning Labels          |       |
| Component Identification                         |       |
| Equipment Nameplates                             |       |
| Diagrams and Operating Instructions              |       |
| Emergency System Equipment Identification        |       |
| Warning Signs, Markers, & Device Labels          |       |
| Electrical Demolition                            |       |
| Electrical Acceptance Testing                    |       |
| Medium Voltage Electrical Service & Distribution | 26-13 |
| System Operating Characteristics                 |       |
| Design Guidance                                  |       |
| System Description                               |       |
| Locating & Routing of Primary Distribution       |       |
| Medium-Voltage Cable                             |       |
| Shielded MV105 Cable                             |       |
| Specification                                    |       |
| Non-Shielded MV105 Power Cable                   |       |
| Acceptable Manufacturers                         |       |
| Medium-Voltage Cable Terminations                |       |
| Acceptable Manufacturers                         |       |
| Medium Voltage Cable Testing                     |       |
| Raceway Systems for Medium-Voltage Cables        |       |
| Design Guidance                                  |       |

# Table of Contents

|  |              |
|--|--------------|
| Aboveground Installations                                  |              |
| Medium-Voltage Switchgear                                  |              |
| Indoor Medium-Voltage Switchgear                           |              |
| Outdoor Medium-Voltage Switchgear                          |              |
| Pad Mount Switches   |              |
| Description  |              |
| Application  |              |
| Installation   |              |
| Clearances   |              |
| Metal-Enclosed Interrupter Switchgear                      |              |
| Description  |              |
| Application  |              |
| Metal Clad Switchgear                                      |              |
| Description  |              |
| Equipment  |              |
| Application  |              |
| Medium-Voltage Transformers                                |              |
| Indoor Dry-Type Medium-Voltage Transformers                |              |
| Outdoor Oil-Filled Pad Mounted Medium-Voltage Transformers |              |
| Acceptable Manufacturers                                   |              |
| Installation   |              |
| Transformer Capacity                                       |              |
| <b>Low-Voltage Electrical Service &amp; Distribution</b>   | <b>26-29</b> |
| System Description   |              |
| Secondary System Characteristics                           |              |
| Load Analysis & Building Main Service-Entrance Rating      |              |
| Normal Power   |              |
| Standby/Emergency Power                                    |              |
| Building Service-Entrance Equipment                        |              |
| Service (or Utility) Transformer                           |              |
| Secondary Unit Substation                                  |              |
| Overhead Low-Voltage Utility Service                       |              |
| Underground Low-Voltage Utility Service                    |              |
| Main & Auxiliary Electrical Equipment Rooms                |              |
| Electrical Metering  |              |
| Low-Voltage Power Factor Correction                        |              |
| Surge Protection for Low-Voltage Distribution              |              |
| Low-Voltage Switchgear, Switchboards, & Power Panelboards  |              |
| Design Guidance  |              |
| Low-Voltage Dry-Type Transformers                          |              |
| General-Purpose Dry-Type Transformers                      |              |
| Transformer Loading  |              |
| Grounding & Bonding for Low-Voltage Distribution           |              |
| Grounding Electrode System                                 |              |
| Circuit and System Grounding                               |              |
| Separately-Derived Systems                                 |              |
| Raceway Systems for Low-Voltage Conductors                 |              |
| Low-Voltage Conductors                                     |              |
| <b>Conductors &amp; Cables</b>                             | <b>26-45</b> |
| Wiring Color Codes   |              |
| Building Wire and Cable                                    |              |
| <b>Lighting &amp; Branch Circuit Wiring</b>                | <b>26-45</b> |
| Raceways & Boxes   |              |

## Table of Contents

|  |       |
|--|-------|
| Flexible Conduit   |       |
| Boxes  |       |
| Wiring Devices & Connectors                                    | 26-46 |
| Motors & Motor Controllers                                     | 26-48 |
| Electric Motors  |       |
| Variable Frequency Drives (VFDs)                               |       |
| Grounding & Bonding  | 26-49 |
| Enclosure and Equipment Grounding                              |       |
| Isolated Grounding Systems                                     |       |
| Interior Lighting  | 26-49 |
| General  |       |
| Design Criteria  |       |
| Classroom Areas  |       |
| Egress & Emergency Lighting                                    | 26-51 |
| Exterior Lighting  | 26-52 |
| Standby/Emergency Power  | 26-52 |
| Diesel-Engine-Driven Generator Sets                            |       |
| <br>   |       |
| Campus Specific Information                                    |       |
| <br>   |       |
| Texas A&M University   | 26-53 |
| Utility Metering   |       |
| Electricity Metering at Service Entrance & Sub-metering Levels |       |
| Diesel Generator Requirements                                  |       |
| Life Safety Transfer Switch                                    |       |
| Approved Generator Manufacturers                               |       |
| Approved Transfer Switch Manufacturers                         |       |
| Tarleton State University                                      | 26-56 |
| Electricity Metering   |       |
| Lighting   |       |
| West Texas A&M University                                      | 26-56 |
| Low-Voltage Conductors   |       |
| Color-Coding   |       |
| <br>   |       |
| Guide Specifications   |       |
| <br>   |       |
| Electric Motors  | 26-58 |
| <br>   |       |
| <b>Division 27 - Communications</b>                            |       |
| <br>   |       |
| Telecommunications Facilities                                  | 27-1  |
| Telecom Equipment Rooms  | 27-1  |
| Building Telecommunications Entrance Facilities                | 27-2  |
| Building Primary Terminal Room Facilities                      | 27-2  |
| Floor/Zone Terminal Closet Facilities                          | 27-3  |
| Station Telecommunications Cable Distribution Facilities       | 27-4  |

## Table of Contents

|   |       |
|---|-------|
| Station Telecommunications Outlet Facilities              | 27-4  |
| Cable Testing   | 27-5  |
| Additional Requirements                                   | 27-5  |
| Intercom and Audio Visual Systems                         | 27-7  |
| Cable Television Systems                                  | 27-7  |
| <br>  |       |
| Campus Specific Information                               |       |
| <br>  |       |
| Texas A&M University                                      | 27-8  |
| Telecommunications & Computer Infrastructure Requirements |       |
| Telecom Equipment Rooms                                   |       |
| Building Primary Terminal Room Facilities                 |       |
| Floor/Zone Terminal Closet Facilities                     |       |
| Station Telecommunications Cable Distribution Facilities  |       |
| Station Telecommunications Outlet Facilities              |       |
| Cable Testing   |       |
| Additional Requirements for Texas A&M University          |       |
| Emergency Telephones                                      |       |
| Distributed Antenna System (DAS)                          |       |
| Audio/Video for Register-Controlled Classrooms            |       |
| Metering and Building Automation Communications           |       |
| West Texas A&M University                                 | 27-16 |
| Telecommunications & Computer Infrastructure Requirements |       |
| Tarleton State University                                 | 27-16 |
| Summary   |       |
| Quality Assurance   |       |
| Testing   |       |
| Identification, Labeling and Documentation                |       |
| Approved Equipment List                                   |       |
| Cable TV Requirements                                     |       |
| <br>  |       |
| <b>Division 28 - Electronic Safety and Security</b>       |       |
| <br>  |       |
| General Information                                       |       |
| <br>  |       |
| Fire Detection and Alarm Systems                          | 28-1  |
| <br>  |       |
| Campus Specific Information                               |       |
| <br>  |       |
| Tarleton State University                                 | 28-1  |
| Fire Alarm System   |       |
| Texas A&M University-Commerce                             | 28-1  |
| Fire Alarm System   |       |



# Table of Contents

## Guide Specification

|  |      |
|--|------|
| Texas A&M University<br>Fire Alarm Specification | 28-2 |
|--|------|

## Division 31 - Earthwork

### General Information

|  |      |
|--|------|
| Site Clearing                                      | 31-1 |
| Topsoil  | 31-1 |
| Grading  | 31-1 |
| Excavation, Trenching and Backfilling of Utilities | 31-2 |
| Lime Stabilization                                 | 31-3 |
| Termite Treatment                                  | 31-3 |
| Void Space Below Grade Beams                       | 31-3 |

## Division 32 - Exterior Improvements

### General Information

|                   |      |
|-------------------|------|
| Site Paving       | 32-1 |
| Concrete Walks    | 32-3 |
| Bicycle Racks     | 32-4 |
| Trash Removal     | 32-4 |
| Porches and Steps | 32-4 |
| Landscape         | 32-4 |
| Irrigation        | 32-5 |

### Campus Specific Information

|   |       |
|---|-------|
| Texas A&M University<br>Irrigation Materials<br>Plant Materials | 32-8  |
| Tarleton State University<br>Site Furnishings                   | 32-10 |

## Division 33 - Utilities

### General Information

|                             |      |
|-----------------------------|------|
| Sanitary Sewerage Utilities | 33-1 |
| Storm Drainage Utilities    | 33-2 |
| Water Utilities             | 33-3 |

## Table of Contents

|   |       |
|---|-------|
| Concrete Utility Boxes                                    | 33-4  |
| Chilled and Heating Water Distribution                    | 33-4  |
| Electrical Distribution                                   | 33-5  |
| Date/Telecom Distribution                                 | 33-5  |
| Site Lighting   | 33-5  |
| Site Telephones   | 33-6  |
| Manholes  | 33-6  |
| <br>  |       |
| <b>Campus Specific Information</b>                        |       |
| <br>  |       |
| Texas A&M University                                      | 33-6  |
| High Density Polyethylene Piping Installation             |       |
| Manhole Covers  |       |
| Telecommunications Manhole                                |       |
| Exterior Site Lighting                                    |       |
| Overhead Distribution                                     |       |
| Prairie View A&M University                               | 33-31 |
| Site Lighting   |       |
| <br>  |       |
| <b>Design Process</b>                                     |       |
| <br>  |       |
| General   | B-1   |
| <br>  |       |
| Integrated Design   | B-1   |
| <br>  |       |
| Program of Requirements Development                       | B-1   |
| <br>  |       |
| Overall Design Process                                    | B-1   |
| <br>  |       |
| Programming and Space Verification                        | B-4   |
| <br>  |       |
| Schematic Design  | B-5   |
| <br>  |       |
| Minimum Requirements for final Schematic Design Submittal |       |
| Drawings  | B-6   |
| Reports   | B-8   |
| Cost Estimates  | B-9   |
| Completion of Schematic Design                            | B-9   |
| <br>  |       |
| Design Development  | B-9   |
| <br>  |       |
| Minimum Requirements for Design Development Submittal     |       |
| Drawings  | B-11  |

## Table of Contents

|   |      |
|---|------|
| Reports                                     | B-13 |
| Specifications                              | B-15 |
| Cost Estimates                              | B-15 |
| Completion of Schematic Design              | B-15 |
| Guaranteed Maximum Price                    | B-16 |
| Formatting of GMP Documents                 | B-16 |
| Construction Documents                      | B-17 |
| Progress Meetings                           | B-17 |
| 100% Construction Documents Review          | B-17 |
| Bidding and Contract Award Stage (CSP Only) | B-18 |
| Contract Award                              | B-20 |
| A/E Bid Analysis (Competitive Bids Only)    | B-20 |
| Construction                                | B-21 |
| Pre-Construction Conference                 | B-21 |
| BIM Transition                              | B-21 |
| Monthly Construction Meetings               | B-21 |
| Color Boards                                | B-21 |
| Subcontractor Best Value Recommendations    | B-22 |
| Shop Drawings and Submittals                | B-22 |
| Coordination Drawings                       | B-23 |
| Substitution Requests                       | B-24 |
| Inspection                                  | B-24 |
| Record Drawings                             | B-24 |
| COBie Data                                  | B-24 |
| FM Global Final Acceptance                  | B-25 |
| FM Global Plan Review Submittal Procedures  | B-25 |

## General Requirements

### Terms and Definitions

|  |     |
|--|-----|
| The Texas A&M University System                | C-1 |
| Office of Facilities Planning and Construction | C-2 |
| System Offices                                 |     |

## Table of Contents

|   |      |
|---|------|
| Office of HUB and Procurement Services                  | C-3  |
| System Members  | C-3  |
| Other Definitions                                       | C-4  |
| <b>Administrative Procedures and Requirements</b>       |      |
| General   | C-5  |
| Payment Schedule for A/E, CMAR & D-B Services Agreement | C-5  |
| Authorization for Reimbursable Services                 | C-5  |
| Authorization for Additional Services                   | C-6  |
| Approvals/Notifications                                 | C-6  |
| Distribution of Documents                               | C-7  |
| Correspondence & Reports                                | C-7  |
| Pending Issues Report                                   | C-7  |
| Data Furnished to A/E                                   | C-8  |
| Changes in Design                                       | C-8  |
| Schedule of Planning                                    | C-8  |
| Reviews   | C-8  |
| Drawing Requirements                                    | C-9  |
| Specification Requirements                              | C-12 |
| Request for Bid Proposals (CSP Only)                    | C-15 |
| Federal General Requirements                            | C-15 |
| Alternates (CSP Only)                                   | C-16 |
| Unit Prices (CSP Only)                                  | C-16 |
| Addenda   | C-16 |
| Printing and Binding Requirements                       | C-16 |
| Electronic Drawing Files                                | C-17 |
| Electronic File Names                                   | C-17 |
| Electronic Folder Names                                 | C-18 |
| Record Drawings   | C-18 |
| COBie Data Sets   | C-19 |
| Cost Control  | C-19 |
| Coded Estimate System                                   | C-19 |
| Cost Estimate Format                                    | C-21 |

### Historically Underutilized Business Program

The Texas A&M University System Office of Facilities Planning and Construction is committed to promoting the participation of minority, women-owned, and small businesses through the Historically Underutilized Business (HUB) Program for the procurement of goods and/or services. The procurement process utilized by the A&M System seeks to provide equal opportunity and equal access in the design and construction opportunities on projects managed by Facilities Planning and Construction.

### General Information

The “Facility Design Guidelines” is intended as guidance for the project architect/engineer team and the contractor team during the design and construction process for The Texas A&M University System Capital Projects. The content covers specific design criteria, the design process and administrative procedures for permanent buildings on A&M System campuses. Subsets of this document will pertain to renovation, civil, etc. type projects. Many but not all requirements for each Campus or Agency of the A&M System are covered. The Project A/E, CMAR or D-B shall also refer to items covered in their Services Agreement and in the project’s Program of Requirements (POR).

The “Facility Design Guidelines” shall be used along with the project specific Program of Requirements and the Services Agreement.

In the event of conflict between this document and specific project requirements the A/E, CMAR or D-B shall contact the Project Manager with Facilities Planning & Construction for clarification.

The guidelines in this document are not intended to prohibit the use of alternative methods, systems, products or devices not covered in this document. All alternatives shall be documented by the A/E, CMAR and D-B and submitted to the Project Manager for approval by Facilities Planning & Construction prior to implementation.



## **Design Philosophy**

### **Design Quality**

The Texas A&M University System Office of Facilities Planning & Construction is committed to excellence in the design and construction of buildings for the A&M System Member Universities and Agencies. To accomplish this the Office of Facilities Planning and Construction (FPC) is committed to the highest quality of aesthetics in meeting the requirements of the Member Universities and Agencies while at the same time delivering a project that is cost effective to operate and maintain throughout its useful life.

All buildings shall be designed with flexibility in mind. Over the life of all major campus buildings the functions will change and the spaces will be reconfigured.

### **Campus Design Standards**

The building design shall follow the guidelines established in the University or Agency Master Plan as well as the guidelines in this document. In the event of a conflict between standards established in a Master Plan and this document the Campus Master Plan shall govern. In lieu of master plan guidelines the design shall blend with campus standards and neighboring buildings. The design shall also conform to neighboring building setbacks, roof lines, etc.

### **Operating & Building Maintenance**

Systems and materials incorporated into all buildings should be selected on the basis of long term operations and maintenance costs. The design should incorporate ease and efficiency of operation and allow for easy and cost effective maintenance and repair. Standardization of equipment, parts, and lamps is also the key to reducing maintenance costs and allows for stocking of common replacement parts. The Project A/E should obtain constant feedback from the Member Facilities Department during design. Detailed instructions from the Project A/E stating the design intent for all building systems and the operating/maintenance procedures are required during the design process.

### **Sustainability & Energy Performance**

The design of all buildings shall incorporate established principles of sustainable design and energy efficiency. Design following these principles improves the buildings performance while enhancing the occupant's health, satisfaction and performance. Sustainable design is an integrated approach in which all phases of the building life

cycle are considered. The energy performance of the building should exceed any requirements per codes.

Project A/E shall include a rainwater collection system from building roof drains and condensate return for irrigation use.

## **Codes and Standards**

Comply with all state and Federal laws applicable to construction. The Project A/E and the FPC Project Manager shall also cooperate with municipalities when tying into local utilities.

## **General Requirements**

The Project A/E shall design A&M System projects to comply with the current Facilities editions of the following codes and standards and advise the Owner of code revisions having impact on the project design.

The State Fire Marshal is the code Authority Having Jurisdiction (AHJ) for all issues pertaining to NFPA 101 Life Safety Codes. Texas A&M University Environmental Health and Safety Department has been delegated the local AHJ for projects on A&M College Station campus. Facilities Planning and Construction is the code authority having jurisdiction (AHJ) for A&M System construction projects for all codes other than NFPA 101 Life Safety Codes. FPC is responsible for facilitating resolution of conflicts and interpretations for these non-NFPA 101 codes after a thorough and joint discussion with the A&M System Member.

The Project A/E shall prepare a written codes and standards analysis, "Building Code Analysis," for each project for review by FPC. This analysis shall provide a side-by-side comparison of the requirements of the listed codes and standards. The comparison shall include all code items and an indication of which code requirement is being applied to the project. In the absence of a careful and thorough discussion by the design team of a specific conflict between the codes, the default is to design to the more stringent or robust code. These code discussions are project-specific and on an item by item basis within the codes. The final approved Building Code Analysis shall be included in the construction documents for future reference.

In the event of the need for interpretation among the codes and standards, the Project A/E shall inform FPC of the need for an interpretation and FPC will establish the requirements for compliance.

Local municipal building codes are not applicable to construction on State of Texas properties, which includes all properties owned by The Texas A&M University System.



However, if it is necessary for a local authority to review any aspect of the project, such review shall be arranged by the System Member representative.

FPC may also require the Project A/E to comply with certain provisions from the local fire department that provides fire protection services for the System Member. These provisions may include locations and dimensions for firefighting access, including fire lanes; locations and specifications for stand pipes, fire hose cabinets, fire control room, and fire hose connections; elevator requirements; and other similar matters.

The Project A/E shall be required to provide a statement that the project is designed in compliance with applicable codes and standards. The following statement shall be included on the general information page adjacent to the project building code summary.

“Life Safety Code Compliance: The Architect/Engineer of Record acknowledges that construction projects for the Texas A&M University System must, at a minimum, be designed in accordance with the requirements of National Fire Protection Association (NFPA) 101, Life Safety Code, as currently adopted by the State Fire Marshal, Texas Government Code sec. 417.008(e). Therefore, the Architect/Engineer of Record affirms that, to the best of his/her professional judgment, knowledge, and belief, the design of this project satisfies the requirements of NFPA 101, Life Safety Code, as well as any other codes or standards made applicable to the project by the professional services agreement.”

## **Design Basis**

1. National Fire Protection Association National Fire Codes, with emphasis on NFPA 101 - 2009 Edition, Life Safety Codes (LSC) and including all referenced standards.
2. International Building Code 2009 Edition

## **Architectural Design**

1. NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals as applicable
2. Texas Department of Licensing and Regulation (TDLR)  
Elimination of Architectural Barriers Act, Article 9102, Texas Civil Statutes and Texas Accessibility Standards (TAS)  
Elevators and Escalators, Health & Safety Code chapter 754 and 16TAC § 74  
ASME 17.1, 17.2, 17.3 and 18.1  
Boilers, Health & Safety Code chapter 755 and 16TAC § 65  
ASME Boiler and Pressure Vessel Code
3. Americans with Disabilities Act, 28 CFR Part 35 Nondiscrimination on the Basis of Disability in State and Local Government Services, Final Rule, as

published in the Federal Register Friday, July 26, 1991

4. Fair Housing Act accessibility requirements for housing units.
5. FM Global Standards for roof systems

### **Civil/Structural Design**

1. ACI – 318-02, building code requirements for reinforced concrete  
AISC, specification for the Design, Fabrication and Erection of Structural Steel
2. Texas Department of Insurance requirements First Tier Coastal Counties wind load criteria
3. FEMA 100 year flood plain designation
4. TCEQ SWPPP Requirements

### **Mechanical and Plumbing Design**

1. International Mechanical Code 2009 Edition
2. International Plumbing Code 2009 Edition
3. International Fuel Gas Code 2009 Edition
4. ASHRAE 62.1 Indoor Air Quality Standard
5. ASME/ANSI B31.9 Building Service Piping.
6. FM Global Standards for fire protection systems

### **Electrical Design**

1. National Electric Code 2011 edition

### **Communications Design**

1. TIA/EIA Standards

### **Energy and Water Conservation Design**

1. Energy Conservation Design Standard for New State Buildings (including major renovation projects), current edition, State Comptroller's Office, Government Code sec. 447.004 and 34 TAC § 19.32  
ASHRAE / IESNA 90.1 2010 Edition
2. International Energy Conservation Code (IECC) 2009/Chapter 4 (Residential/Apartments)
3. SECO Alternative Energy Evaluation Requirements
4. SECO Water Efficiency Standards for State Buildings and Institutions of Higher

Education Facilities – January 2011

## Acoustic Design

Design in accordance with good practice to achieve conventional ambient noise levels qualified in Noise Criteria (NC) defined in current ASHRAE Applications Volume, Chapter 42 and ANSI S1.8 Reference Quantities for Acoustical Levels – ASA 84.

The ambient sound level of an occupied space is not to exceed the following NC listed for its respective typical occupancy unless specifically directed otherwise by the System Member representative or the project Program of Requirements. Spatial forms, materials, assemblies, systems and equipment selections are to be designed as required to achieve a standard quality of specified level of maximum background noise.

| Typical Occupancy              | Maximum Noise Criteria (NC) |
|--------------------------------|-----------------------------|
| Apartment/Dorms                |                             |
| Individual rooms/suites        | 35                          |
| Meeting/Banquet rooms          | 35                          |
| Halls, corridors & lobbies     | 40                          |
| Service/support areas          | 45                          |
| Offices                        |                             |
| Executive                      | 30                          |
| Conference Rooms               | 30                          |
| Private                        | 35                          |
| Open plan areas                | 40                          |
| Business machine areas         | 45                          |
| Public circulation             | 45                          |
| Research, Hospital and Clinics |                             |
| Private rooms                  | 30                          |
| Wards                          | 35                          |
| Operating rooms                | 25                          |
| Laboratories                   |                             |
| Research & general             | 35                          |
| Teaching                       | 30                          |
| Corridors                      | 35                          |
| Public Areas                   | 40                          |
| Lecture & classrooms           | 30                          |

These conventional standards of the level of ambient noise in a space are independent of

and prior to the installation of any Owner-furnished equipment, furniture and furnishings unless specified otherwise.

Other resource material describing conventional ambient noise criteria is available in the current edition of Ramsey/Sleeper Architectural Graphic Standards.

The Project A/E is required to submit sealed documents for an accessibility review. The required review should be accomplished by a Registered Accessibility Specialist located near the project site. The same Registered Accessible Specialist (RAS) will be utilized for the plan review and the post construction inspection.

The A/E will be required to secure permits from state and federal government agencies when necessary, such as Texas Department of Highways and Public Transportation, Health Department, etc. The cost of any permits will be borne by the Owner.

If the project site is along the Texas coast the Project A/E is expected to provide design details and specifications to meet Texas Windstorm certification requirements. The design team will include an individual certified and authorized to make the required design decisions, submittal reviews, and on-site inspections of the building during construction (to include signing the certification documentation) to ensure compliance with the Windstorm certification requirements.

The Project A/E will complete and submit the Energy Conservation Design Standard Certification form for Nonresidential Buildings and compliance forms required by ASHRAE 90.1-2010 as part of the required Energy Report to the FPC Project Manager.

The project A/E will complete and submit the Energy Conservation Design Standard Certification form for Residential Buildings and compliance forms required by the International Energy Conservation Code (IECC-2009) as part of the required energy report to the FPC Project Manager.

## **Environmental Practices**

### **Sustainable Design**

All buildings shall be designed to achieve LEED 2009 Silver requirements. Refer to the project POR to determine if the building shall be certified through U.S. Green Building Council. The A/E shall prepare a checklist to determine the theoretical level of certification. The A/E is responsible for updating this checklist and providing updates at project milestones to the project team. These updates shall include explanations of the point changes. All buildings shall be designed to maximize daylighting, maximize human comfort and minimize energy use.

## **Energy Performance**

All new buildings shall be designed to exceed the requirements of ASHRAE 90.1-2010 by 14%. All existing building renovation projects shall be designed to exceed the requirements of ASHRAE 90.1-2010 by 11%. Energy modeling by the project team will be required to verify energy performance of buildings.

Residential projects, as defined by the State Energy Conservation Office (SECO), shall be designed to comply with International Code Council's International Energy Conservation Code, IECC 2009.

## **Daylighting**

In order to maintain a relationship between the building occupants and the outdoors, direct views of the outside must be provided for at least 75% of the regularly occupied areas unless the needs of the spaces dictate otherwise. The building design should strive to provide outside views for 100% of all offices in the building.

If daylighting systems, beyond windows, are included in the design for daylight harvesting the project team must take special concern to ensure adequate daylight illumination, avoid common glare issues and fully integrate the lighting and mechanical systems with the interior architecture and daylighting systems.

## **Building Materials**

Wherever possible, products, and materials with recycled-content and no volatile organic compounds (VOC) shall be specified in the building design.

## **Indoor Air Quality**

The design shall follow ASHRAE 62.1-2007

## **Commissioning**

All building projects shall employ commissioning practices to assure delivery of program goals and related performance requirements. The Project A/E shall coordinate commissioning practices with the FPC Project Manager, the Facilities Department, the Commissioning Authority (if contracted separately) and the contractor (if the delivery method is construction manager at risk or design-build) during design. Commissioning scope and practices are to comply with current FPC standards. The commissioning agent is responsible for updating the BIMs and COBie data with the as-commissioned data produced during the commissioning process.

## Life Cycle Cost Analysis (LCCA)

### Purpose

The Texas A&M University System has a long tradition of designing and constructing high quality buildings. Continuing this tradition, Facilities Planning and Construction seeks to ensure that all buildings meet student, faculty and staff needs as efficiently and cost effectively as possible. Cost effectiveness of a design is therefore a key component and Life Cycle Cost Analysis (LCCA) is a design process for evaluating and controlling the initial and future cost of building ownership. Life Cycle Cost Analysis (LCCA) is defined by the National Institute of Standards and Technology (NIST) Handbook 135 as the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or building system over a period of time. NIST Handbook 135 is available at [www.bfrl.nist.gov/oa/publications/handbooks/135.html](http://www.bfrl.nist.gov/oa/publications/handbooks/135.html)

LCCA is based on the premise that multiple building design options can meet programmatic needs and achieve acceptable performance, and that these options have differing initial costs, operating costs, maintenance costs, as well as different life cycle costs. By comparing the life cycle costs, LCCA can show the trade-offs between low initial first cost and long-term cost savings. Thus, the most cost-effective system for a given use can be identified, and the length of time it will take to “pay back” the incremental cost for this system can also be determined. In keeping with the A&M System’s sustainability practices, LCCA can identify environmentally desirable solutions. Careful design choices that result in efficient use of energy, water and other resources often yield long-term cost savings. In addition, should environmentally friendly choices not save money over time, LCCA may reveal that their additional cost over time is minimal. These guidelines define the LCCA process, and establish the standards and metrics to ensure accurate and consistent life cycle data collection and evaluation across projects.

### General Requirements

During the Schematic Design (SD) and Design Development (DD) phases of a project, the A/E is required to perform a minimum of three (3) LCCA comparative analyses from several building system categories. Two of the three analysis shall relate to energy conservation. Each LCCA comparative analysis can have up to four (4), or more, alternatives (one base case plus three alternate cases). Building system categories are as follows, but are not limited to:

### Energy Systems

1. Central plant vs. stand alone system chillers and boilers

2. Equipment options for stand-alone systems (air cooled chillers vs. refrigerant-based direct expansion [DX] units)
3. Additional pipe or duct insulation
4. Alternative energy systems
5. Use of heat recovery systems and other energy saving systems and equipment

## **Mechanical Systems**

1. Air distribution systems (variable volume vs. constant volume, overhead vs. under floor).
2. Water distribution systems (various piping systems and pumping options)

## **Electrical Systems**

1. Indoor lighting sources and controls
2. Use of natural lighting and day lighting controls
3. Outdoor lighting sources and controls
4. Power distribution (transformers, buss ducts, cable trays)

## **Building Envelope Systems**

1. Building skin options (masonry, precast, metal panels)
2. Additional building insulation
3. Roofing systems (types, materials, insulation methods)
4. Glazing, daylight, and shading options

## **Building Interior Construction**

1. Floor covering (carpet, terrazzo, tile, vinyl tile)
2. Interior partitions (movable vs. fixed)

## **Building Siting/Massing**

1. Orientation, floor to floor height, and overall building height
2. Landscape, irrigation, and hardscape options

## **Structural Systems**

1. Systems/materials selection (wood vs. steel vs. concrete, cast-in-place vs. pre-cast)
2. Foundation system (slab on grade, structural, crawl space, drilled piers, auger cast, pilings, spread footings)

## Selecting Cost Effective Alternatives

Alternatives that result in a payback of 5 years or less are required to be incorporated into the project. Alternatives that result in a payback of 6 to 10 years are strongly encouraged to be incorporated into the project. Alternatives with a payback greater than 10 years are optional.

### LCCA Software

Project A/E shall use either of the following software programs for LCCA analysis

BLCC – Available from NIST at  
[www1.eere.energy.gov/femp/information/download\\_blcc.html](http://www1.eere.energy.gov/femp/information/download_blcc.html)

User Friendly Life-Cycle Costing – A spreadsheet implementation of BLCC and available at [www.doe2.com](http://www.doe2.com)

### The LCCA Process

The LCCA process involves the Project A/E and FPC, Physical Plant and Users (Project Team) and requires that they establish clear objectives, determine the criteria for evaluating alternatives, identify and develop design alternatives, gather cost information, and develop a life cycle cost for each alternative.

The Project Team should establish clear objectives in evaluating alternatives. LCCA can capture dollar cost variations between alternatives and show which option has the overall lowest cost.

The two metrics to be used and calculated in the LCCA are the Life Cycle Cost of each alternative and its Payback over an agreed upon study life. Consideration is given to total costs and the time it takes to recover an incremental initial investment incorporating the time value of money. As mentioned above, Life Cycle Cost is defined as the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or building system over a period of time.

The Project Team should develop up to four alternative designs. The first alternative design is the “base case” and is the standard design or minimum requirement for a project. The base case is typically identified as having the lowest initial cost of all the alternatives. The remaining three alternative designs are developed to evaluate against the “base case.” The Project Team should use their experiences and judgment in selecting relevant building and system component alternative designs.



For each alternative design, the Project A/E should gather cost information. Cost information should include, but not be limited to, the following:

### **Initial Costs**

1. Construction costs (labor, materials, equipment, etc.)
2. Soft costs (design fees, permit fees, etc.).

### **Annual Future Costs**

1. Operating Costs (utility costs such as electricity, gas, water, steam, chilled water, etc. and service costs such as custodial, etc.)
2. Maintenance Costs (preventative and reactive)

### **Non-Annual Future Costs**

1. Replacement Costs (planned maintenance, renovation at a future date, etc.)
2. Demolition Costs (if required)

Note: Residual Value default is set at zero (\$0) for all studies and not included in LCCA unless otherwise directed.

For each alternative, including the base case, the Project A/E should calculate the LCC and Payback metrics. Each alternative should be evaluated using these two metrics, and recommendations should be made as to which alternative design should be incorporated into the project.

All LCCA efforts should be completed in the Design Development phase of the project. If the design changes during Construction Documents the LCCA shall be modified to reflect the change.

## Building Elements Lifespan

|                          | Institutional | Commercial | Apartments |
|--------------------------|---------------|------------|------------|
| Structural Foundation    | 80 yrs        |            |            |
| Slab on Grade Foundation |               | 50 yrs     | 30 yrs     |
| Subgrade                 |               |            |            |
| Waterproofing/Drainage   | 40 yrs        |            |            |
| Building Structure       | 80 yrs        | 50 yrs     | 30 yrs     |
| Exterior Walls           | 80 yrs        | 50 yrs     | 30 yrs     |
| Exterior Windows         | 40 yrs        | 40 yrs     | 30 yrs     |
| Exterior Doors           | 40 yrs        | 40 yrs     | 30 yrs     |
| Roofing                  | 20 yrs        | 20 yrs     | 20 yrs     |
| Interior Partitions      | 20 yrs        | 15 yrs     | 15 yrs     |
| Interior Doors           | 20 yrs        | 20 yrs     | 15 yrs     |
| Interior Finishes        | 15 yrs        | 10 yrs     | 5 yrs      |
| Elevators                | 25 yrs        | 20 yrs     | 20 yrs     |
| Equipment                | 25 yrs        | 20 yrs     | 15 yrs     |
| Furnishings              | 20 yrs        | 15 yrs     | 10 yrs     |
| Plumbing Rough-in        | 80 yrs        | 50 yrs     | 30 yrs     |
| Plumbing Fixtures        | 30 yrs        | 30 yrs     | 30 yrs     |
| HVAC Boilers/Chillers    | 30 yrs        | 30 yrs     | 15 yrs     |
| HVAC Equipment           | 20 yrs        | 20 yrs     | 15 yrs     |
| HVAC Distribution        | 40 yrs        | 40 yrs     | 30 yrs     |
| Fire Protection System   | 40 yrs        | 40 yrs     | 30 yrs     |
| Fire Detection System    | 20 yrs        | 20 yrs     | 20 yrs     |
| Electrical Rough-in      | 80 yrs        | 50 yrs     | 30 yrs     |
| Electrical Equipment     | 30 yrs        | 30 yrs     | 30 yrs     |
| Lighting                 | 30 yrs        | 30 yrs     | 20 yrs     |
| Communications           | 20 yrs        | 20 yrs     | 15 yrs     |

Institutional - Permanent campus buildings

Commercial - Non-educational support buildings or developer building

Apartments - Wood frame student housing

## Space Standards

### Calculation of Building Areas

The method used to calculate the assignable square feet and gross square feet in a building is based on guidelines from The Texas Higher Education Coordinating Board (THECB). These guidelines are intended to establish common standards for building inventory for all state institutions of higher education. In large part these guidelines are also based on those from the U.S Department of Education, National Center for Education Statistics.

Gross area should be computed by measuring from the outside face of exterior walls, disregarding cornices, pilasters, buttresses, etc., which extend beyond the wall face. The gross area includes all floored spaces from ground level through top floor. It includes basements (except unexcavated portions), attics, garages, enclosed porches, penthouses, mechanical equipment floors, lobbies, mezzanines, balconies (inside and outside) utilized for operational functions, and corridors (provided they are within the outside face lines of the building).

The sum of floor areas of a building included within the exterior walls for all stories or areas that house floor surfaces including attics, basements, sub-basements, penthouses, mechanical rooms, etc. These are areas with six foot six inch clear headroom or areas with lower ceilings that are usable for storage or other purposes.

Gross area does not include open courts and light wells, or portions of upper floors eliminated by rooms or lobbies which rise above single floor ceiling height.

Net Assignable Area is defined as the sum of all areas within the interior walls of rooms on all floors of a building assigned to or available for assignment to, an occupant or use, excluding unassignable space.

Unassignable area of a building is the sum of space within a building not assigned to directly support academic programs. Included in this are:

Building support areas used for the protection, care and maintenance of a building, circulation areas such as corridors and stairwells, Mechanical areas which are areas designed to house mechanical equipment, utility services and shaft areas, Inactive areas space in a building that once was assignable but is permanently no longer in use, shell space or unfinished space designed to be converted into usable space at a later date and public restrooms which are accessible to the public.

Area shall be derived from the BIMs. The A/E is responsible for maintaining the areas in the BIMs.

## Building Core Elements

### First Floor Elevation

The first floor elevation of all new buildings where possible shall be equivalent to the 500yr predicted flood elevations, plus 2ft. (FEMA flood level predictions are based on a statistical average, with standard deviation of +/-2ft).

Where new buildings cannot be located above the 500yr or 500yr+2ft flood levels, the first floor elevation shall at least 1 to 2 feet above the 100yr flood elevation, and high-value equipment, ornate interior finishes and critical operations or research laboratories should be located on a level above the 500yr+2ft flood elevations.

The storm-water management system shall use grading and drainage sufficient to route predicted rain-water for the 100-yr, 24-hr rainfall event. The system should primarily rely on grading to direct water away from the building, with limited reliance on storm-water drainage systems directly adjacent to building openings or outside equipment. Building designs with below-grade spaces such as basements, service tunnels, etc. are discouraged in areas subject to flooding. Should below-grade service areas or basements be required, they should not have openings located below the 500yr+2ft in areas subject to flooding, or below grade of the surrounding terrain in areas not subject to flooding.

### Building Entrances

All main entry points to a building must be provided with a vestibule that performs as an air lock and; have walk-off mats acceptable to the System Member Physical Plant Department. Weather protection must also be provided for the exterior doors at a minimum this shall consist of door sweeps, weather seals at the door head and jambs, drips at the bottom of the door, and over head rain drips above the door that extend at least 8" beyond the jambs of the door.

### Building Circulation

The building circulation system (corridors) should be clearly designed to lead building occupants from entrances to their destination. It is desirable to introduce as much natural light as possible into corridors, through windows, transoms or borrowed light. Utility systems should be routed in circulation pathways to provide access to utilities without disrupting occupied spaces.

Doors on opposite sides of corridors shall be offset to prevent direct viewing from one room to another. Classroom and laboratory room doors opening into corridors shall be recessed the width of the door to eliminate corridor obstructions.

Building corridors are to have sufficient above ceiling space to accommodate all of the required equipment and provide maintenance access and code required clearances to that equipment. The A/E shall establish and distribute for review the above ceiling stratification. The A/E shall also establish routing strategies for equipment that may run at the same elevation in the ceiling plenum on opposite sides of the corridor.

The A/E shall model clearances required for all above ceiling equipment for coordination purposes.

### **Crawl Space Under Suspended Structural Foundations**

Where plumbing access or future flexibility is required by the Member Facilities Department provide an accessible crawl space with 2 inch thick, 2500 psi unreinforced mud slab, properly sloped and drained. Crawl space must be provided with lighting, weather proof electrical outlets, and ventilation (minimum 2 air changes per hour) along with adequate access hatches and access ladders. Access to the crawl can be through floor hatched in the mechanical room or an area way on the perimeter of the building. Access shall not be through electrical rooms, telecommunications rooms, or custodial rooms. Switches for crawl space lighting shall be located near access hatches so that the lighting can be turned on prior to entry. The minimum clearance in crawl space shall be determined by Member Facilities Department and the crawl space shall maintain negative pressure relative to the first floor.

### **Egress Stairs**

The location and design of egress stairs within buildings should encourage their use for everyday vertical circulation. Magnetic door hold open devices, interconnected to the building fire alarm system, are allowed to keep interior doors to egress stairs in an open position to encourage their use.

### **Equipment Rooms**

All mechanical and electrical equipment rooms must be designed with adequate aisle space and clearances around equipment to accommodate maintenance from the floor and replacement of items. There must be a defined pathway from all equipment rooms to the building exterior of adequate size to permit the replacement of equipment. Means of removal of equipment shall be by the most cost efficient path approved by the System Member Facilities Department. Plans and elevations for all equipment rooms, at a scale not less than  $\frac{1}{4}'' = 1'-0''$ , shall be prepared for each room to indicate that adequate

circulation and maintenance areas are provided. The A/E shall model all required clearances and pulls required for maintenance and repair of equipment for coordination purposes. All equipment rooms must be designed to control noise transmission to adjacent spaces including corridors. Depress the floor of all mechanical rooms 1-1/2 inches and uniformly slope the entire floor to minimum 4 inch floor drains connected to the building sanitary sewer system.

## **Electrical Closets**

Electrical closets must be designed so that three walls stack vertically and NO wall is centered on a structural beam that would interfere with vertical risers. Do not route building utility capable of conveying liquids through or above electrical closets. The only exception allowed is the branch sprinkler line serving only the sprinkler head in an electrical closet. NFPA 13 allow the electrical closet to be unsprinklered if a 2 hour wall and door are used. Access to electrical closets must be from within the building from the corridor system and not through any other space. Door should open out from space to maximize usable interior floor and wall area.

## **Main Switchgear room**

The main electrical switchgear room for a building should be located on the ground floor. It shall never be located below restrooms, custodial closets or at an elevation that requires sump pumps for drainage. The layout of the room shall comply with the National Electric Code requirements for minimum clearances.

## **Communication Closets**

Communication closets must be designed so that all four walls stack vertically and NO wall is centered on a structural beam that would interfere with vertical risers. Communication closets must be provided on each floor and located such that no wiring run exceeds 270 feet. A single communication closet can generally serve 10,000 square feet of floor space. Access to communication closets must be from within the building from the corridor system and not through any other space. Door should open out from space to maximize usable interior floor and wall area.

## **Air Handler Rooms**

Air Handler rooms should be designed so that they stack vertically and NO wall is centered on a structural beam that would interfere with vertical risers. The spaces must be arranged and sized to provide maintenance staff with safe access to all pieces of equipment for routine maintenance. Access to air handler rooms must be from within the building from the corridor system and not through any other space. Door should open out from space to maximize usable interior floor and wall area. Provide a

minimum of 2 feet clearance on two sides and one end of the air handlers. Provide clearance for removing coils and filters. These clearances shall be modeled for coordination purposes. Air handler rooms shall be insulated for sound.

## **Rest Rooms**

Rest rooms must be located on each floor and should be located within 200 feet of every occupied space. Rest rooms should be grouped with custodial closets for ease of maintenance and to reduce plumbing runs. Rest rooms should be sized to accommodate a minimum fixture count determined by the International Plumbing Code (IPC) and accessibility based on the Texas Accessibility Standards. Rest rooms serving assembly areas must accommodate short term, high volume traffic and will require higher fixture counts. Also, the number of fixtures for women's rest rooms shall be higher than minimum determined by the IPC. The increase will vary according to project and campus, up to a fixture ratio of 1/3 men to 2/3 women. Confirm this with the campus Facilities Department. Either the built in trash receptacle shall be located adjacent to the restroom door or there shall be floor space available next to the door for the placement of a large trash can.

All high traffic restrooms on ground floor shall be designed with airport style entry (no doors) and trash receptacles of adequate capacity for traffic volume.

Direct or reflected lines of sight into restrooms and dressing rooms from the corridor are prohibited.

Provide at least one accessible family friendly restroom containing one water closet, one lavatory and a diaper changing station. Location should be adjacent to building entrance or elevator lobby on first floor.

## **Loading Dock**

Provide a loading dock at each new building. The loading dock and service yard shall be screened from major streets and views. Refer to the POR and Facilities Department for specific requirements for loading dock.

## **Trash Dumpsters/Trash Compactors**

Provide a concrete pad either in the loading dock service yard or a separate screened enclosure for trash dumpsters. Refer to the POR for any specific requirements for dumpsters or the need for a compactor. Refer to the Facilities Department for the type of dumpsters used, access requirements, and any other equipment or area requirements that may be needed for the equipment.

## Recycling Room

A recycling area should be provided for each building located adjacent to the loading dock or service entrance. This space will allow for sorting of recyclables such as paper, glass and metals. Refer to the local Facilities Department for details on campus recycling programs.

## Custodial Closets

Should consist of 80 sq. ft. minimum floor space, include shelf, mop sink and hand operated eye wash. The minimum clear width of a custodial closet is six feet. A closet of this size can serve a floor area up to 50,000 gross square feet (gsf). Building designs with floor areas larger than 50,000 gsf shall require more than one custodial closet per floor. Door should open out from closet to maximize usable interior floor and wall area. Custodial closets shall not have telephone, cable television, data, mechanical or electrical cables or equipment in it nor roof or under floor access through it. The custodial closet should be located near the restrooms on each floor.

Smaller custodial closets approved by FPC Project Manager and Facilities Department may be utilized in outlying small buildings but they should have the basic items such as mop sink, shelving, mop and broom hangers, and room enough to store cart and floor buffer. These custodial closets should have an area of not less than fifty (50) square feet and a minimum clear width of five feet.

Custodial closet shall contain the following:

1. Standard 2'x2'x8" floor corner mounted mop sink located close to door.
2. Wall surface materials around the mop sink must be moisture resistant.
3. Provide six mop hangers, above the mop sink and twelve mop and broom hangers along wall near the mop sink. If mop hanger has an integrated shelf it should be mounted 72 inches minimum above finish floor.
4. Provide shelving on one side wall, at least four 12" shelves 16" to 18" apart with the bottom one being mounted approximately two feet above the floor. Adjustable heavy duty shelving systems are acceptable.
5. Overhead fluorescent lighting controlled from switch just inside door.
6. One electrical duplex outlet on each side wall. Use GFI outlets where required by code when placed near a water source.
7. Wall hung lavatory near door with hand held eye wash.

## Server Room Requirements

Almost every building has a requirement for one or more server rooms. Some buildings house mission critical servers and as such have more stringent environmental



requirements. The size and intensity of a server room is not usually known during the concept or design phase of a building. Due to rapid advances in technology, the equipment that served as a basis for design is not the equipment that will be installed at owner occupancy. The trend has been for servers to get smaller in physical size yet increase the quantity of power supplies and heat rejection into the space. Thus more equipment with a greater heat and power load is being placed into spaces that were not designed to handle either the power or thermal loads.

Some installations have electrical power installed at levels of 20 kW per rack. While this may be excessive in a university environment, there are some universities that have started using these design criteria. In an effort to anticipate some of this effect, provide the following:

1. Each server room shall be furnished with an electrical service that equals at least 200 watts per square foot. This works out to approximately 7 kW per rack. Some spare capacity must be included. Present design criteria require about 3 kW per rack. A computer grade panel board should be furnished in each server room.
2. Each server room should be served from a standby generator. As the servers become more mission critical this requirement becomes essential.
3. The thermal requirements for all server rooms should be supplied first from the building thermal utilities with humidity control and secondary back up in the form of an independent DX system. The power for the secondary system should be from a standby generator. Special consideration should be given to consolidating server rooms into one centralized server room. Server rooms should be designed with sufficient capacity to operate at 48 degree chilled water supply to meet planned and future loads.
4. Each server room must have some form of entry access control.
5. If the server rooms are unmanned and remote some form of environmental monitoring and alarm should be provided.
6. The server room minimum width shall be 11' based on a single row of racks in the center of the room. The length shall be determined by the number of racks plus the required circulation space on each end.
7. Racks of back-up batteries supporting UPS and other back-up systems should be located in a separate Battery Room, with no normal opening between the two areas. Lead/Acid batteries that overheat release corrosive by-products that can deposit chemical residues on computer equipment circuitry that requires extensive decontamination or replacement. Overcurrent protection should be provided.

While the power and thermal requirements are considerably less, the telecom closets should be likewise provisioned. There are other applications that require increased consideration for reliability and environmental controls that must be evaluated on a case by case basis.

## Floor and Space Identification Systems on Drawings

Each space shall be identified by name as identified in the Program of Requirements or as agreed to by the FPC Project Manager and the User Coordinator and room number.

Room numbers used in the Construction Documents will become the actual and permanent space numbers.

All equipment placed in or above a space shall use the space and floor number as identifying parametric data.

## Assignment of Floor Numbers

The floor level containing the primary entrance shall be considered the First Floor and shall be numbered in the 100 series; the floor above being the Second Floor shall be numbered in the 200 series. Third and subsequent floor shall be numbered in a similar manner. Basement level shall be numbered 001 series.

## Assignment of Room Numbers

The rooms on each floor opening off of either side of a corridor shall be numbered consecutively in a clockwise direction from the primary entrance which shall be 100. If there is more than one main entrance to the building use the one mutually agreed to by the FPC Project Manger and the User Coordinator.

Rooms and spaces not opening off a corridor shall carry the room number of the connecting room with an additional suffix letter (108A, B, C, etc.). Letter clockwise, if more than one room is involved.

Corridors, vestibules and other areas and spaces which have not been assigned numbers by the Campus maybe assigned numbers for completing room finish schedules and for use in reference notes and correspondence. These numbers are not to be considered permanent numbers.

## Campus Specific Requirements

### Texas A&M University

### Energy Performance

All new buildings shall be designed to exceed the requirements of ASHRAE 90.1-2010 by 18% and 14% in existing building renovations. Additionally, all projects are required to

earn 5 points within EA credit 1, under the USGBC's LEED 2009 rating system. Energy modeling by the project team will be required to verify energy performance of buildings.

## **Commissioning**

The Project A/E shall coordinate commissioning practices with the FPC Project Manager, the Facilities Services, the Commissioning Authority (if contracted separately) and the contractor (if the delivery method is construction manager at risk or design-build) during design.

## **Family Rooms**

Provide at least one family rest room containing one fixture, one lavatory and one diaper changing station. Locate on ground floor near other rest rooms.

## **Maintenance Service Area**

In all building at Texas A&M University, for every 25,000 gsf of building area 50 nsf shall be set aside as a maintenance service area. This space shall be located on the first floor level near the service entrance and loading dock.

## **Vending Standards**

1. Provisions for vending machines should be considered in new buildings with occupancies greater than 25 people.
2. At a minimum, space should be allocated for 3 vending machines. Allow 4ft. wide x 4ft. deep for each vending machine. For recessed or alcove applications with ceiling drops, allow minimum 7 ft. clear height for vending machines.
3. Vending areas should be located in spaces that are readily visible to the public, both occupants and visitors. Vending should be located along the most frequently and highly traveled traffic areas in the building. Vending signage is helpful, but location of machines is more critical.
4. Provide a dedicated GFCI duplex receptacle (on separate 20 amp breaker) for each vending machine. Receptacles should be located directly behind each machine. Refrigerated soft drink machines will average 10 to 13 amps when compressor is running. Compressors can pull up to 30 amps for a few seconds during start-up.
5. Provide a data drop for debit card (Aggie bucks) readers on vending machines. Run conduit to communications room in the building.
6. Accessible routes should be considered for installation and servicing of vending machines. Ground floor locations are preferred on two story buildings. Elevator access is required on second floor and above locations. Access and docking or

parking for vending product (truck) deliveries to the building should be provided. Ramps should be provided for dolly traffic on approaches to service entrances.

7. Provide space for trash containers and recycling container (aluminum cans) in or near vending areas.
8. If provided as a part of project, vending machines shall be compliant with Energy Star Program Requirements for Vending machines to ensure minimum energy consumption.

## **West Texas A&M University**

### **Main Switchgear Room**

At WTAMU basement or below grade main electrical switch gear rooms are acceptable with walls separating it from other building functions.

### **Maintenance Service Area**

In all building at WTAMU, for every 25,000 gsf of building area 50 nsf shall be set aside as a maintenance service area. This space shall be located on the first floor level near the service entrance and loading dock.

### **Vending Standards**

1. Provisions for vending machines should be considered in new building with occupancies greater than 25 people.
2. At a minimum, space should be allocated for 3 vending machines. Allow 4ft. wide x 4ft. deep for each vending machine. For recessed or alcove applications with ceiling drops, allow minimum 7 ft. clear height for vending machines.
3. Vending areas should be located in spaces that are readily visible to the public, both occupants and visitors. Vending should be located along the most frequently and highly traveled traffic areas in the building. Vending signage is helpful, but location of machines is more critical.
4. Provide a dedicated duplex receptacle (on separate 20 amp breaker) for each vending machine. Receptacles should be located directly behind each machine. Refrigerated soft drink machines will average 10 to 13 amps when compressor is running. Compressors can pull up to 30 amps for a few seconds during start-up.
5. Provide rough-in for debit card (Buffalo Gold Card) readers on vending machines. Rough-in to include a wall mounted duplex box with ¾" conduit and pull string stubbed above ceiling. Buffalo Gold Card uses Cat 5 UTP Ethernet communication cables (gold jacket). All communication cable shall be run from the communications room demark to the wall mounted duplex box. If there is

more than one duplex box (for a bank of vending machines) the wire shall "LOOP" through "continuously" in a single run from one duplex box to the next leaving at least 12' of loop wire at each box.

6. Accessible routes should be considered for installation and servicing of vending machines. Ground floor locations are preferred on two story buildings. Elevator access is required on second floor and above locations. Access and docking or parking for vending product (truck) deliveries to the building should be provided. Ramps should be provided for dolly traffic on approaches to service entrances.
7. Provide space for trash containers and recycling container (alum. cans) in or near vending areas.

## **Texas A&M University-Texarkana**

### **Maintenance Service Area**

In all building at Texas A&M University-Texarkana, for every 25,000 gsf of building area 50 nsf shall be set aside as a maintenance service area. This space shall be located on the first floor level near the service entrance and loading dock.

### **Vending Standards**

1. Provisions for vending machines should be considered in new buildings with occupancies greater than 25 people.
2. At a minimum, space should be allocated for 3 vending machines. Allow 4ft. wide x 4ft. deep for each vending machine. For recessed or alcove applications with ceiling drops, allow minimum 7 ft. clear height for vending machines.
3. Vending areas should be located in spaces that are readily visible to the public, both occupants and visitors. Vending should be located along the most frequently and highly traveled traffic areas in the building. Vending signage is helpful, but location of machines is more critical.
4. Provide a dedicated GFCI duplex receptacle (on separate 20 amp breaker) for each vending machine. Receptacles should be located directly behind each machine. Refrigerated soft drink machines will average 10 to 13 amps when compressor is running. Compressors can pull up to 30 amps for a few seconds during start-up.
5. Provide a data drop for debit card readers on vending machines. Run conduit to communications room in the building.
6. Accessible routes should be considered for installation and servicing of vending machines. Ground floor locations are preferred on two story buildings. Elevator access is required on second floor and above locations. Access and docking or parking for vending product (truck) deliveries to the building should be provided. Ramps should be provided for dolly traffic on approaches to service entrances.

7. Provide space for trash containers and recycling container (aluminum cans) in or near vending areas.
8. If provided as a part of project, vending machines shall be compliant with Energy Star Program Requirements for Vending machines to ensure minimum energy consumption.

## General Information

The following Division 0 Sections have been developed by Facilities Planning & Construction and are to be utilized on all A&M System projects. The FPC Project Manager will provide the Project A/E with a final copy of all Division 0 Sections for insertion into the project specifications.

If the Project A/E has additional sections or changes to these sections these items shall be brought to the attention of the FPC Project Manager. If the additions or changes are agreed upon then the final copy supplied by the FPC Project Manager will reflect the agreed upon items.

In no event will the Project A/E modify the final sections supplied by the FPC Project Manager.

The following is a listing of the standard Division 0 Sections for Construction Manager at Risk and Design-Build delivery methods:

- Guaranteed Maximum Price Proposal
- Performance Bond, Form C-6A
- Payment Bond, Form C-6B
- Uniform General and Supplemental Conditions, Form C-8
- Special Conditions and Wage Rates
- Soil Investigation Data

The following is a listing of the standard Division 0 Sections for Competitive Sealed Proposal delivery method:  
(Examples of some of these files are located in the Appendix)

- Request for Competitive Sealed Proposal
- Instructions for Competitive Sealed Proposal, Form C-3 CSP
- Supplemental Instructions for Competitive Sealed Proposal
- Bid/Proposal Bond, Form C-2
- Part 1, Competitive Sealed Proposal
- Part 2, Proposer's Qualifications
- Part 3, HUB Subcontracting Plan
- Part 4, Subcontractors' Qualifications and Cost Reduction Considerations
- Post Proposal Amendment
- Addenda
- Contract, Form C-5a
- Performance Bond, Form C-6A

**Design Criteria**  
**Division 0 – Procurement and Contracting Requirements**

Payment Bond, Form C-6B

Uniform General and Supplemental Conditions, Form C-8

Special Conditions and Wage Rates

Soil Investigation Data



## General Information

The following Division 1 Sections have been developed to work with the Uniform General and Supplemental Conditions and the Special Conditions and are to be utilized on all A&M System projects. The FPC Project Manager will work with the Project A/E to complete Section 01 11 00 – Summary of Work and Section 01 23 00 – Alternates. The FPC Project Manager will provide the Project A.E with a final copy of all Division 1 Sections for insertion into the project specifications.

If the Project A/E has additional sections or changes to these sections these items shall be brought to the attention of the FPC Project Manager. If the additions or changes are agreed upon then the final copy supplied by the FPC Project Manager will reflect the agreed upon items.

In no event will the Project A/E modify the final sections supplied by the FPC Project Manager.

The following is a listing of the standard Division 1 Sections:

- 01 11 00 - Summary of Work
- 01 23 00– Alternates (CSP Only)
- 01 25 00 - Contract Modification Procedures
- 01 29 00 - Payment Procedures
- 01 31 00 - Project Management and Coordination
- 01 31 50 - Project Meetings
- 01 32 00 - Construction Progress Documentation
- 01 33 00 - Submittal Procedures
- 01 34 00 - Shop Drawings, Product Data and Samples
- 01 42 00 - References
- 01 43 00 - Quality Assurance
- 01 45 00 - Quality Control
- 01 50 00 - Temporary Facilities and Controls
- 01 61 00 - Basic Product Requirements
- 01 63 00 - Substitution Procedures
- 01 72 50 - Field Engineering
- 01 73 50 - Cutting and Patching
- 01 74 00 - Cleaning
- 01 77 00 - Closeout Procedures
- 01 78 00 - Closeout Submittals

**Design Criteria**  
**Division 1 – General Requirements**

## **General Information**

### **Survey**

A topographic survey will be performed for each project involving new construction and for renovation projects where necessary by a surveyor licensed in the State of Texas.

The survey shall include information for, but not limited to, topography, existing construction (buildings, roads, sidewalks, etc.), existing utilities on site including closest point of connection if not on site, significant vegetation, easements, etc.

The survey shall be drawn using a BIM authoring program and final copy shall be plotted. The survey shall be modeled at 1:1 scale. All dimensions and elevations shall be in English units. The plotted scale shall be 1.0" = 20.00' and the title block shall include the project name and project number. The final drawing shall be sealed by a Texas RPLS, if requested. Upon completion of the survey provide two copies of the plotted survey and one DVD or CD-ROM containing the native CAD file, an IFC copy of the file, as well as an ASCII file of the point elevations. The CD shall be professionally labeled containing project name and project number.

#### **Specifically the Survey Shall:**

Include a legend of symbols and abbreviations used on the drawing, a north arrow and a graphic scale.

Provide contours at 1 foot intervals unless directed otherwise by the System Civil Engineer with an error not to exceed 1/2 contour interval.

Provide at least two horizontal and one vertical control points with description and elevation to nearest .01'. Datum shall be NAD 83 for horizontal and NGVD 88 for vertical.

Provide spot elevations at street intersections and curb, crown of roads, sidewalks, edge of paving including far side of paving, drainage flow line, manhole rims/covers, top and bottom of retaining walls, etc. Spot elevation on paving or other hard surface shall be to the nearest .05' and spot elevations on other surfaces to the nearest .1'

Include the location of above and below ground structures, man-made and natural features; all floor elevations and finish floor elevations at each entrance of buildings on the property, if applicable.

Include the location, size and depth of water, gas and thermal utilities. For depths, coordinate with the Facilities Department.

Include the location of fire hydrants available to the property and the size of the main

serving each.

Include the location and characteristics of power and communications systems above and below grade.

Include the locations, size, depth and direction of flow of sanitary sewers, combination sewers, storm drains and culverts serving or on the property; location of catch basins, manholes, and inverts of pipe at each.

Provide the name of operating authority of each utility. Utility information can be provided by the Facilities Department. Additional information will also be provided by Facilities Planning Division.

Provide the mean elevation of water in any excavation, well or nearby body of water.

Provide the location of 1% annualized potential and 0.2% annualized potential (100yr & 500-yr) floodplains..

Provide the extent of watershed onto the property.

Provide the location of trees along with the species name in English, the caliper in inches and the canopy width.

Provide the perimeter outline only of any thickly wooded areas unless otherwise directed.

Show boundary lines, giving length and bearing (including reference or basis) on each straight line; interior angles; radius, point of tangency and length of curved lines. Where no monument exists, set permanent iron pin (monument) or other suitable permanent monument at property corners; drive pin into ground to prevent movement, mark with wooden stake; state on the drawing(s) whether corners were found or set and describe each.

Survey shall be reviewed by FPC Project Manager and Facilities Department before being finalized.

## **Hazardous Materials Assessment**

Hazardous Materials Assessments will be considered on a project by project basis. The A/E may need to include in the reimbursable services portion of the A/E Services Agreement the cost for hazardous materials assessments for asbestos, lead, mold or any other materials. The hazardous materials assessment firm is to possess all of the licenses, registrations and qualifications to perform services in the State of Texas.

## **Geotechnical Investigations**

If included as a reimbursable service in the A/E Services Agreement the A/E shall include the services of a qualified Geotechnical firm.

### **Proposal for Geotechnical Services**

Borings proposed by the geotechnical engineer are to be indicated on a map with depths.

Where drilled piers are involved, provide a separate hourly rate and a not to exceed cost (based upon 1 trip and 8 hours of time) to be onsite during the first day of pier drilling to verify bearing stratum and other field conditions.

Schedule of rates are to be attached to proposal.

### **Drilling & Sampling Methods**

Drilling and sampling in accordance with current applicable ASTM standards.

Samples taken at ground surface, at two feet below existing grade and at each change in soil stratification or soil consistency, but not further apart than five feet in each of the borings unless specified.

Rock cores, if applicable are not to be less than 1 3/8" in diameter.

Samples shall be preserved and filed logs prepared by an experienced soil technician.

Make any necessary pavement repairs of like material.

### **Field & Laboratory Reports**

All parts of the report are to be made on white or off white paper measuring 8 1/2 x 11 inches, suitable for photocopying and bound in booklet form. If larger drawings are absolutely necessary, they shall be folded to 8 1/2 x 11 inches to fit into the report booklet.

Written reports and analysis shall be on geotechnical firm's letterhead.

Include with the report a chart illustrating the soils classification criteria and the terminology and symbols used on the boring logs.

Identify the ASTM or other recognized standard sampling and test methods utilized.

## Design Criteria Division 2 – Existing Conditions

Provide a plot plan with horizontal location and ground elevation of test borings using same datum as survey.

Provide vertical sections for each boring plotted and graphically presented showing the number of borings, sampling method used and date of start and finish.

Soil classified in the field logs in accordance with current applicable ASTM and other standards.

Surface elevation at all bores.

Description of soil and thickness of each layer

Hydraulic pressure required or number of blows per foot (N value) and where applicable

Depth to loss or gain of drilling fluid

Depth to wet cave-in

Depth to artesian head

Ground water elevation and time when water reading was made (repeat observation after 24 hours)

Presence of gases.

Location of strata containing organic materials, wet materials or other inconsistencies that might affect engineering conclusions.

Description of the existing surface conditions and summarize the subsurface conditions

As a minimum, the following tests are to be performed: Moisture Contents, Atterberg Limits, Percent Passing #200 Sieve, Hydrometer, Pocket Penetrometer, Unconfined Compression and Unit Dry Weight.

### **Foundation Evaluation & Recommendations**

Foundation support of the structure and slab, including soil bearing pressures, bearing elevations foundation design recommendations, including drilled piers/auger cast piles, potential vertical rise and anticipated settlement.

Anticipation and management of groundwater.

## Design Criteria Division 2 – Existing Conditions

Lateral earth pressures for design of walls below grade, including backfill, compaction and sub drainage and associated requirements.

Soil material and compaction requirements for site fill, construction backfill and for the support of structures and pavements.

### **Pavement Design**

Design criteria for temporary excavation, temporary protection such as sheet piling, underpinning and temporary dewatering system.

### **Stability of Slopes**

Analysis of soils to ascertain presence of potentially expansive, deleterious, chemically active or corrosive materials or conditions or the presence of gas.

### **Deliverables**

Two final reports sealed by a Texas Registered Professional Engineer with the project name and project number on the cover page and one DVD or CD-ROM with the report in Acrobat “PDF” format. The PDF shall contain a Table of Contents linked to the corresponding pages.

### **Demolition**

All site demolition shall be indicated on a separate demolition plan indicating all items to be turned over to the Facilities Department and all trees and vegetation that shall remain and be protected during construction.

Perform all demolition of existing surface and underground facilities/improvements as required to construct the project. Demolition plans/details shall be included in the design drawings. Underground facilities shall be removed as required to clear construction and in accordance with good prudent practice and considering potential future construction. At a minimum all structures shall be removed to a point 3' below natural ground. All cavities left below ground shall be filled with compacted native material or a flowable fill material. The portions of piping systems remaining in place shall be neatly cut and capped/plugged. Where partial demolition occurs the remaining portions shall be left in a finished functional condition.

Fill all voids left by clearing and demolition operations with native material compacted in maximum 8" lifts to a density equal to that of the surrounding undisturbed soil.

## **Tree Protection**

Provide adequate tree protection around all trees in project site that are to remain. Also, refer to Division 1 for additional information



## General Information

### Concrete

All concrete shall be designed, transported, placed, finished and cured in accordance with American Concrete Institute (ACI) requirements. Components of the concrete mix shall meet applicable ANSI/ASTM requirements. Mix requirements and strength shall be specified by the Design Team for each item of construction. Limit the number of mix strengths specified as much as practical.

Concrete form work shall meet applicable ACI requirements.

Concrete reinforcement material, design and placement shall meet the applicable requirements of ACI and the Concrete Reinforcing Steel Institute (CRSI) along with associated ASTM requirements. Reinforcing bars shall typically be Grade 60. No welded wire fabric reinforcing is allowed except in topping slabs or unique situations as approved by the FPC Project Manager. Main reinforcing bars to be minimum No. 4 in size. Limit No. 3 bars (Grade 40) to ties and dowels.

Admixtures to the concrete mix meeting applicable ANSI/ASTM specifications may be used as recommended by the structural engineer to improve concrete workability, wear/weather resistance characteristics, etc., to better meet project conditions. Pozzolan Admixtures should be used only within the limits recommended by the structural engineer and approved by the Owner.

The project specifications shall clearly establish finish measurement tolerances/standards suitable to the intended use of the surface and its exposure along with other quality control requirements needed to verify the concrete meets the specifications.

Curing compound manufacturer is to provide certification that their product is compatible with the finish flooring scheduled for the space.

The CM/GC is responsible for creating a BIM of the cast-in-place concrete building structure from which shop, fabrication, and as-built drawings shall be derived.

### Void Space Below Grade Beams

Provide soil retainers at face of grade beams below grade to form a void of sufficient depth to prevent expansion of earth to cause pressure on bottom of beams. Acceptable product is SureRetainer by MotzBlock.

## General Floor Loading

Design floor live loads on all institutional buildings to carry a minimum of 100lbs/sf unless greater is required by Code and/or use for a particular space such as library shelving. This allows flexibility of future design when the building is renovated. Floors must be designed sufficiently rigid to prevent objectionable vibration. All other buildings the design live loads shall be by the building code.

## Porches and Steps

All stoops, porches, ramps, docks and steps, exterior and interior should have non-slip surfaces and nosings where applicable. Slope exterior porches and treads where allowed by Texas Accessibility Standards to drain water. Ponding of water in these areas is unacceptable. Exposed concrete finished work shall be accomplished in two pours: the first structural and the second being a two inch minimum finish topping poured near completion of project.

Primary entry floors may not be constructed using brick or pavers since these surfaces are excessively noisy when carts are rolled across them.

## Cement Finished Floors

Generally cement finished floors are to receive hardener with colorant. Positive protection is to be provided to prevent staining and chipping during construction work. Slick finishes shall be avoided.

## Crawl Space Under Suspended Structural Foundations

Where a crawl space is included in the design provide a 2 inch thick, 2500 psi unreinforced mud slab, properly sloped and drained. (For further information see *General Information "Crawl Space Under Suspended Structural Foundations"*).

## Concrete Reinforcing

No welded wire fabric shall be used for reinforcing concrete except in topping slabs. All other reinforcing shall be by bars.

## Precast, Tilt-up and/or Special Finished Concrete

On projects designed for precast, tilt-up and/or special finished concrete, the Specification shall require a sample panel, constructed all as specified, or at least 42 square feet to be erected at the jobsite for approval consideration by the Director of Project Delivery. The approved panel shall remain on the jobsite as a visual criterion which the final construction must match.

## **Roof Decks**

The preferred material for flat roof decks is concrete. Where the roof is supported by a combination of structural steel, steel joists and steel deck, the topping shall be standard weight concrete.

The main slope for the roof shall be accomplished by the structural system. Only secondary slopes can be accomplished by the roof system.

## **Mow Strips**

Include a 2' wide x 4" thick continuous reinforced concrete mow strips around the building in grassed areas which will require mowing. The mow strip shall be doweled to the building foundation at all door locations. At all other locations the mow strip shall not be doweled to the building foundation unless approved otherwise by the System Civil Engineer.

Include a mow strips along and doweled to the back of curb in grassed areas adjoining head in parking areas which are subject to car bumper overhang. Mow strip to be sloped in the direction of drainage. Jointing shall be provided to match that in the adjoining curb.



## General Information

### Brick

Brick masonry to be designed and constructed per the standards of the Brick Industry Association.

### Brick Selection Procedure

Brick will be selected during project design and shall be specified in the bid documents.

Face Brick shall be ASTM C216; Type FBS grade SW.

In the drawings the A/E will provide a detail that indicates the size of the brick mock-up panel that will also contain all exterior materials such as stone, cast stone, curtain wall, glazing, sealants, etc. for final approval of brick color as well as all exterior colors for the project.

**The A/E shall require, in the Project's Specification along with a detail in the drawings, that prior to ordering brick, the Contractor shall erect a 300 brick sample panel in mortar, all as specified, at the jobsite for final approval consideration by the Director of Project Delivery or designee.**

The approved panel shall remain on the jobsite as a visual criterion which the final construction must match.

Mortar shall be Type N with concave tooled joints.

Expansion joints and control joints in masonry veneer walls shall be appropriated detailed and shown on building elevations. Extra precautions shall be taken at Texas A&M International University due to extreme summer temperatures.

### Concrete Masonry Units (CMU)

Concrete masonry units shall be used wherever feasible for back up to exterior face brick.

Concrete masonry units shall comply with ASTM C90.

Use bullnose type concrete masonry units at all edges and exterior corners.

### Stone

Limestone shall be no closer than 4 inches to grade when adjacent to lawns and planting areas. Interior limestone masonry shall be sealed.

Marble and granite shall be domestic.

Anchors, dowels and other accessories used in setting stone shall be stainless steel.

## **Overhead Masonry**

Construction where the masonry units are supported overhead using concealed mechanical devices in tension, or where the units extend beyond lower courses using concealed mechanical support devices in tension shall not be used. Building being renovated where these conditions exist shall be thoroughly examined for safety and a report of condition provided.

## **Masonry Accessories**

Mortar net or a comparable mortar collection product shall be added to the base of brick veneer and single wythe concrete masonry walls to prevent clogging of weep holes.

## **Campus Specific Information**

### **Texas A&M University**

#### **Brick**

Acme Brick: ELP Blend No. 172 Modular Velour Paloma Grey

Acme Brick: PEP Blend No. 250 Modular Velour Royal Oak

Boral Brick: Stone Castle #103

Interstate Brick: Modular Velour Valley Tan

Interstate Brick: Modular Velour Tumbleweed

#### **Cut Stone**

Cordova Cream Texas Limestone

#### **Cast Stone**

Cast Stone shall be mixed thoroughly dry as follows: One (1) sack Atlas White Portland Cement with one (1) oz. of Lanbert Bright Yellow Color. After Blending the above, use the following mixture:

Four (4) parts "Big Sandy" sand to one (1) part of blended cement color mixture.  
Stone should match stone on TAMU Northside Parking Garage.

## **Tarleton State University**

### **Brick**

Acme Brick: Eureka Plant EBP 635  
Product Code 288880121  
Brick Colors 230, 240, 241 and 260  
Modular Only

Color blends percentage vary depending upon final building location on campus  
and shall be field verified.

Blend Rates:  
Color 230 – 60-70%  
Color 240 – 10%  
Color 241 – 15-25%  
Color 260 – 5-15%

Renovations to Existing Buildings – Brick colors shall be field verified. Note:  
Some of the older buildings have the older brick which is more of an orange brick.

## **Prairie View A&M University**

### **Brick**

Acme Brick: TUP Blends No. 2-25%, 3-30%, 5-35% and 20-10% Modular Velour  
Acme Brick: EUR Blends No. 230-25%, 240-25%, 260-30%, 241-20% Modular Velour  
Cloud Ceramics: Navajo Blend Modular Velour

## **Texas A&M University at Galveston**

### **Brick**

Acme Brick: PEP Blend No. 30 – Dove Grey

## **Texas A&M University-Corpus Christi**

### **Brick**

Acme Brick: PEP Blend No. 58 Shamrock Modular Velour with white mortar

Interstate Brick: Arctic White Modular Velour with white mortar

D'Hanis Brick: Accents Only

## **Texas A&M International University**

### **Brick**

Acme Brick ELP Blend No. 130 Heritage Americana

Acme Brick Blend No. 218 Scratched Face

### **Cut Stone**

Honed Buff Light Range Lueders Limestone, quarried by Featherlite, Texas Quarries Division, Austin, Texas

Dolomite Limestone quarried by Valdars Stone and Marble, Inc., Valdars, Wisconsin.

## **Texas A&M University-Kingsville**

### **Brick**

Acme Brick ELP Blend No. 154 Sierra

Acme Brick ELP Blend No. 102 Yellow/Tan Martini

## **West Texas A&M University**

### **Brick**

Brick and exterior surface colors shall follow the color pallet of the brick and stone on Old Main Building.

## **Texas A&M University-Commerce**

### **Brick**

Acme Brick Blend No. 4 Modular Velour Windsor Park



**Texas A&M University-Texarkana**

**Brick**

Acme Brick TUP Blend No. 20 50% and  
Acme Brick TUP Blend No. 33 50%



## General Information

### Structural Steel

The contractor shall be required to provide an affidavit, at the completion of the project, that the structural steel framing is plumb and level within the normal tolerances specified in the AISC Code of Standard Practice.

The main slope for the roof shall be accomplished by the structural system. Only secondary slopes can be accomplished by the roof system.

The CM/GC is responsible for creating a BIM of the structural steel from which shop, fabrication, and as-built drawings shall be derived.

### Cold-Formed Metal Framing

Cold-formed metal floor and wall framing shall be spaced 16 inches on center, maximum.

### Metal Fabrications

All exterior ferrous metals shall be hot dip galvanized.

Wherever dissimilar metals come in contact with each other, they must be separated with an approved layer of bituminous coating. Galvanized metal or zinc plated fasteners shall not be used to anchor aluminum or copper. Use aluminum or copper fasteners.

### Metal Stairs

Metal stairs with concrete, terrazzo or other similar treads are acceptable for use as egress stairs.

### Lightning Protection System

Ensure lightning protection system is designed to prevent galvanic corrosion between dissimilar metals. Do not use a combination of materials that for an electrolytic couple.

## Campus Specific Information

Texas A&M University at Galveston  
Texas A&M University-Corpus Christi

All exposed exterior ferrous metal shall be stainless steel.

Kynar finish on exterior pipe railings is not allowed.

## **General Information**

Consider specifying products from sustainable sources such as FSC Certified Wood or regionally available from abundant sources. Avoid use of imported or exotic species of woods.

## **Wood Treatment**

Wood used in conjunction with roofing installations and wood which is installed in contact with concrete or masonry shall be pressure treated with an approved preservative to meet AWPS Standards. Other installations shall receive prime coats suitable for finishes specified as soon as installation is complete. Back prime where dampness or warping is anticipated.

## **Sheathing**

The preferable construction for exterior walls is brick with concrete masonry back-up and a gypsum wallboard interior finish material. If the exterior wall is brick with metal stud back-up then the sheathing material shall be Densglass Gold or equal. Gypsum sheathing shall not be used.

## **Finish Carpentry**

Materials and fabrication shall conform to Architectural Woodwork Institute specification for Custom quality work.

## **Millwork**

Materials and fabrication shall conform to Architectural Woodwork Institute “Quality Standards” specification. Use “Custom Grade” for standard millwork and “Premium Grade” for unique and special features.

## **Architectural Wood Casework**

Materials and fabrication shall conform to Architectural Woodwork Institute specification for Premium quality work.

**Design Criteria**  
**Division 6 – Wood, Plastics and Composites**

## General Information

Building Envelope shall comply with State Energy Code, ASHRAE 90.1-2010.

A method to clean all exterior glazing must be incorporated into the project. Verify method with Facilities Department.

## Building Insulation

Maximize insulation value of the building envelope to conserve energy and incorporate an air barrier. Avoid insulation material containing formaldehyde and consider insulations with recycled content.

Non-combustible or FM Approved insulation is recommended in place of foam-based products (polyurethane, polystyrene, etc.), and is especially important in unprotected, concealed spaces, such as attics and crawl spaces, or in hollow-core walls that will be penetrated by electrically-rated equipment..

FM Approved foam insulations for wall/ceiling have been evaluated according to FM Approvals Standard 4880, and are listed at [www.approvalguide.com](http://www.approvalguide.com) under Building Materials/Building Insulation/Foam Insulation.

## Roofing

All new roof assemblies and roof recovers should be an FM Approved Roof Assembly, designed in accordance to the applicable FM Data Sheets: 1-28 *Wind Design*, 1-29 *Roof Deck Securement and Above Deck Components*, 1-31 *Metal Roof Systems*, 1-49 *Perimeter Flashing*, and 1-54 *Roof Loads for New Construction*. All roof submittals should include the FM RoofNav Roof Assembly Identification Number. Further guidance on Wind Design (FM DS 1-28) and FM Approved Roof Assembly Listings is available at [www.roofnav.com](http://www.roofnav.com)

Roofing system shall be determined by local Facilities Department or as indicated in this Division.

Specify service walkways (minimum 2'0" in width) appropriately located to service all roof top equipment from the roof access.

Carefully detail roof expansion joints and flashing.

Completely detail all parapet walls, caps, coping and scuppers. Top of coping should slope toward roofs.

## Design Criteria Division 7 – Thermal and Moisture Protection

Detail roof edges sufficiently high to prevent water from spilling over and spotting walls and fascias where roof drains are used.

Provide drips on overhangs, ledges, window stools and coping to prevent discolorations of fascias, soffits and walls.

Ensure that sealants specified are to be used within their limitations. When pre-cast concrete wall panels are used, ensure proper compatibility between the surface sealant and the concrete panel when caulking a joint.

Flashing materials for permanent type buildings to be aluminum, stainless or copper (not galvanized metal).

Slope roof adequately to drain (minimum 1/4"/ft. slope). Design primary roof slopes for new buildings into structural frame and not by roof insulation. Crickets to roof drains may be sloped with insulation. Metal building roofs (minimum 1/4"/ft. slope).

Lightweight concrete insulating fill roof decks will not be used in conjunction with urethane roof system. Lightweight structural concrete is allowed.

### Specific Campus Requirements

#### Texas A&M University

Building Envelope shall comply with ASHRAE 90.1-2010.

Roof systems for new and existing facilities shall meet International Building Code and NRCA requirements and be selected to meet the specific design requirements of each building considering the following criteria:

- Life Cycle Cost
- Sustainability
- Roof Penetrations
- Roof Traffic to access and repair/maintain roof mounted equipment
- Maintainability of Roof System
- Differential movement
- Historical Requirements
- Visibility from Adjacent Facilities/Aesthetics

Texas A&M University facilities currently use built-up roof systems with Coal-Tar Elastomeric Membrane (CTEM), Sprayed Polyurethane Foam (SPF) Roof Systems and Standing Seam Metal Roofs. Single-ply membrane roof systems are also used and can be specified, but should only be specified for low-traffic roofs with few penetrations. Specified roof systems shall carry a manufacturer's 20-year warranty.



**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

Design shall minimize roof mounted equipment where possible otherwise the design shall include “passive” fall protection such as parapets and/or guardrails.

### **Texas A&M University at Galveston**

Single Ply with FM Global compliant design and uplift tests

### **Tarleton State University**

Single Ply – Sarnafil PVC

Classification: Type II, Grade I, PVC

Membrane Thickness: 72 mils, +/- 2.0 mils

Solar Reflective Index (SRI): 104

Felt Backing: Polyester felt with a weight content of 9 ounces per square yard

Exposed Face Color: White

Pitched Roofs – GAF/ELK Timberline Shingle (Prestique 30 year)

Color: Hunter Green

### **Prairie View A&M University**

Modified Bitumen

### **Texas A&M University-Corpus Christi**

Modified Bitumen

### **Texas A&M International University**

Clay Tile and Single Ply

### **Texas A&M University-Kingsville**

Clay Tile or Modified Bitumen

The clay tile assembly must be nailed AND mortared with at least 2 nails in the field of the roof, and 3 nails in the perimeter and corners areas. Cement grout should be provided in the space under the tile ribs in the first row along the eave. Miami-Dade County Approved Clay Tile Systems are also acceptable, if capable of withstanding the uplift pressures for the geographical area.

Miami-Dade County Approved Listings are available at:  
[www.miamidade.gov/buildingcode/pc-search\\_app.asp](http://www.miamidade.gov/buildingcode/pc-search_app.asp)

**West Texas A&M University**

Single Ply - mechanically attached  
Pitched Roofs – Standing Metal Seam Deck or Composite Shingles

**Texas A&M University-Commerce**

Modified Bitumen

**Texas A&M University-Texarkana**

Fully Adhered TPO Membrane

## Guide Specification

### Urethane Foam Roof System

#### 1.0 GENERAL

1.1 SUBMITTALS: The following shall be submitted for review by the project architect prior to the start of any contract roof work.

A. Data

Submittals which provide descriptions or documentation regarding the work and descriptive information regarding products, materials, equipment, or components to be used in the work.

B. Instructions

Preprinted material describing installation of a product, system or material, including special notices and material safety data sheets, if any, concerning impedances, hazards, and safety precautions.

C. Certificates

Statement signed by an official authorized to certify on behalf of the manufacturer of a product, system or material, attesting that the product, system or material meets specified requirements. The statement must be dated after the award of the contract, must state the Contractor's name and address, must name the project and location, and must list the specific requirements which are being certified.

#### 1.2 SCOPE

- A. This section specifies polyurethane foam roof systems.
- B. Packaging: Materials are to be received in sealed containers of the approved manufacturer; shipped from the factory with legible manufacturer's labels and underwriters labels thereon where applicable.
- C. Batch Date: Age of packaged materials shall be evidenced by the date of batch clearly stamped on the container.
- D. All material shall be new and to be applied within six (6) months from time manufactured as evidenced by the batch date.

#### 1.3 WARRANTY

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

- A. Roofing System: The Contractor shall provide a manufacturer's written warranty, as specified in paragraph 3.5, covering failure of the Foam Roof System against defects in manufacturing, materials, and/or workmanship. Failure is defined to include, but is not necessarily limited to, defects or deterioration of the system resulting in material discoloration, delamination, peeling, or cracking. Warranty period is ten (10) years after the date of substantial completion.
- B. Guarantee Inspections: On expiration of the first year and at least every other year thereafter of the guarantee period, the Coating Manufacturer Accompanied by the Owner shall inspect the urethane foam and coating system to determine the condition of the roof.
1. Any repairs that are necessary shall be accomplished as stated in the guarantee.
  2. The Coating Manufacturer shall submit to the Owner a report stating the results of each inspection as it affects the remaining period of the guarantee.

## 2.0 PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Urethane Foam Roof System shall be UL-790 (ASTM E-108) Class A and UL-723 (ASTM E-84) approved, and comply with International Building Code requirements. Roofing System shall also comply as an assembly with UL 1256, Fire Test of Roof Deck Constructions. Roofing System shall comply with UL-1897 Standard for Wind Uplift and UL-2218 Standard for Impact Resistance.

### 2.1 SPRAY APPLIED MEMBRANE MATERIALS

- A. Primers: As required by Materials Manufacturer for the following items or conditions:
- Non-ferrous metals.
  - Ferrous metals.
- B. All applications shall be applied with the appropriate mil thicknesses as recommended by the approved manufacturer.
- C. Polyurethane Foam: Provide 3 PCF Density, two Component System, 1:1 ratio formulated for use on roofs where smooth surface characteristics are desired.

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

- D. Approved manufacturers: If it meets the criteria of this specification, the following manufacturers will be acceptable;

PSI - S245-30 (SS, RS, WS) Bay Systems North America, Spring, Texas  
Elastospray HPS-81302, BASF, Carrollton, Texas  
RT-2031, Resin Technology, Ontario, California

1. Foam manufacturer shall provide manufacturing date of foam components. Foam shall be applied within six months of date of manufacture.

## 2.2 SILICONE COATING SYSTEM

- A. Silicone coating shall consist of a two-coat system, fluid applied elastomeric membrane with granules for protection of polyurethane foam.
- B. Approved manufacturers: If it meets the criteria of this specification, the following manufacturers will be acceptable:

BASF Elastocoat Silicone 3-5000  
Everest Silicone Coating - Eversil 580  
G.E. Silicone Coating - SCM 3308 Base Coat and SCM 3304 Top Coat  
Neogard RTV Silicone #7850

1. Coating manufacturer shall provide manufacturing date of coating components. Coating shall be applied within six months of date of manufacture.
- C. Granules: Shall be #1 grit blasting sand. Color to be selected from manufacturer's standard colors.

## 2.3 ACCESSORIES

- A. Roof Jacks: As recommended by the roof system manufacturer, high temperature vents shall have insulation sleeve and storm collar. Roof jack construction and installation shall meet requirements of the International Building Code, International Plumbing Code, International Mechanical Code and NFPA 54, National Fuel Gas Code.

## 3.0 EXECUTION

### 3.1 SURFACE PREPARATION

- A. Inspect existing roof system and parapet prior to starting any work. Make note and notify Owner of conditions unfavorable to beginning work.
- B. All ferrous metal flashing, trim, vent stacks, cants, etc. will be cleaned dust

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

and grease free prior to priming with specified primer.

- C. All non-ferrous metals will be cleaned and chromate etched prior to applying specified primer.
- D. No primer will be installed over metals, ferrous or non-ferrous, without a visual inspection by the Owner's representative of all preparation. Failure of inspection may constitute removal of work and work re-attempted until accomplished correctly without any additional cost to the Owner.

### 3.2 APPLICATION OF SPRAY FOAM

- A. Prior to spraying foam the following criteria must be met: Contractor shall give Owner 48 hours notice prior to spraying any material, including primer, foam or coating.
- B. The Contractor shall provide all necessary barricades, signs, warning of spray area as determined in the preconstruction conference. The Contractor shall set these signs out the night before spraying begins.
- C. The Contractor shall be responsible for the removal of signs and barricades at the completion of the job.
- D. The Contractor shall protect any automobile, bicycle, vehicle or other property which is located in a warning area where contact with the Owner has not been made. The Contractor shall secure the property with a polyethylene cover and maintain as necessary during spray operations.
- E. The Contractor shall employ approved wind screens for all foam applications. The Contractor is responsible for all overspray and shall have sole liability where damage occurs as a result of this work. Suspend foam spraying when wind speeds exceed 15 miles per hour.
- F. Spray foam applicator shall be approved by the materials manufacturer. Spray foam operations shall be performed only during adequate period of calm, open weather, roof surface and ambient temperature above 50 degrees F., winds not exceeding 15 miles per hour. Protect all property from overspray or other damage.
- G. Roof surfaces to receive spray foam shall be dry and free of dew or frost. Primer shall be dried free of solvent. One gallon per 100 square feet of surface minimum coverage. Any areas where primer is ponding shall be removed down to existing surface and re-primed with one thin coat of primer.
- H. In areas where total tear off of existing built-up roofing is indicated, apply two inches of new urethane foam roof system as needed to ensure positive

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

drainage.

- I. In areas where partial removal of existing foam roofing is indicated, remove one-half inch to one inch of existing foam and apply one of new urethane foam to ensure positive drainage. Spray foam shall be applied in smooth uniform thickness over the entire area except those areas where greater thickness is required for proper drainage, and where other thicknesses are called for on the drawings. Foam shall be coved onto the walls, projections and feathered smoothly into drains, as indicated by the drawings. Grind foam smooth and trowel around drains for proper drainage.
- J. Low areas, which form puddles, shall be no longer than 18 inches in longest dimension and no deeper than ½ inch. Contractor shall perform a water test 48 hours prior to final inspection, to identify low areas and insure all roof drains are functioning properly.
- K. The quantity of spray foam installed per day shall be regulated by the applicator's capacity to apply protective coating during the same day. Any foam left exposed overnight, to include tie-ins, shall be dried and thoroughly primed prior to continuing with the application of new foam or coating.
- L. Finished Surfaces: The finished surface texture of the applied spray foam shall be free of excessive ridges, bumps and pinholes, etc. "Popcorn" or "Tree Bark" surfaces as defined by the UFCA coating committee are not acceptable. The finished surface shall be in acceptable condition, without water, dew or excessive moisture prior to application of the specified coating system.

### 3.3 PROTECTIVE COATING

- A. The coating applicator shall be approved by the material manufacturer. Protect all property from overspray or other damage.
- B. Protective Coating: Silicone coat shall be applied the same day the foam is applied. ***NO EXCEPTIONS ALLOWED!*** Coating shall not be applied later than one hour prior to sundown. Any late spraying of coating can only be done with Architect's approval.
- C. Equipment: Shall be as required by approved coating manufacturer. Contractor shall submit data on the equipment as specified by the coating manufacturer. Data shall identify, pump ratio, components, pressure ratings and performance criteria.
- D. Silicone Coating, Base Coat: Apply to all horizontal surfaces to yield an average of 8 dry mils thickness on horizontal surfaces and 8 dry mils on vertical surfaces. The base coat shall be applied in a single coat using airless spray equipment. Coating to be sprayed using crosshatch method making

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

sure the entire surface is coated evenly without pinholes, sags or curtains.

**NOTE TO APPLICATOR: Backroll basecoat to ensure adequate seal of existing surface.**

- E. Intermediate Coat: Apply to all horizontal surfaces to yield an average of 8 dry mils thickness on horizontal surfaces and 8 dry mils on vertical surfaces. Coating to be sprayed using crosshatch method making sure the entire surface is coated evenly without areas of pinholes or sags.  
**NOTE TO APPLICATOR: The above quantities should yield a minimum of 16 dry mils must be achieved prior to top coat and granule application. Upon the satisfaction of proper foam texture requirements, these minimum requirements can be achieved. A wet mil gauge should be used to check thickness. Verify application thicknesses by taking sample slits to ensure minimums. Granules cannot be applied until Owner can verify that the manufacturer's required minimum thicknesses have been achieved.**
- F. Silicone Coating, Top Coat: Apply to all horizontal surfaces to yield an average of 8 dry mils thickness and 8 dry mils of vertical surfaces. Coating to be sprayed using crosshatch method making sure the entire surface is coated evenly without areas of pinholes or sage.
- G. Granules: Immediately upon completion of topcoat application, granules shall be uniformly broadcast over the wet silicone, at the rate of 50# per 100 square feet, totally covering the entire silicone roof surface.
- H. Details: Apply an extra heavy coating in each application around all projections, parapet wall, junctions and drains. Coating shall be applied beyond the foam in a double lap coat 4 inches or as far as possible.
- I. Batch Mixing: Shall be as recommended by the approved coating manufacturer. Contractor shall submit for approval all documentation regarding the proper mixing and batching of elastomeric coating material. Identify procedure, process of mixing, equipment required, components and sequencing solvents required.

### 3.3 INSPECTION

- A. The Contractor shall maintain a daily project log containing the following information:
  - 1. Temperature and relative humidity at start time, midday and end of day (sling psychrometer permitted)
  - 2. Wind velocity (speed and direction)
  - 3. Sky conditions (overcast, partly cloudy, etc.)



**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

4. Amount of coated foam or coating installed
5. General remarks

A log shall be submitted to the Architect at the end of each day or as directed by project inspector.

- B The Contractor shall flood the roof with water 48 hours prior to final inspection. This procedure shall be coordinated with and in the presence of the Owner. Flooding will provide a means for checking roof drains, low areas and cleaning of roof prior to final inspection.
  - C The coating manufacturer shall make an on-site inspection, accompanied by the Owner upon completion of the project. The manufacturer shall submit a report to the Owner stating the final results of the on-site inspection and approval of the application of the materials.
  - D The inspection shall include, but not be limited to the following: A slit sample, each 2,000 sf., 2 inches long x ½ inch wide x ¾ inch deep. Slits shall be closed by the Contractor using an approved silicone caulk. Depth of foam shall be measured adjacent to slit area.
1. Film thickness shall be measured. Overall thickness shall average 24 mils, with top coat of 8 mils.  
Thickness shall not vary over .5 mils.
- F. The Architect shall periodically inspect the project for compliance with the specification requirements.

### 3.4 CLEANUP

- A. Limited equipment cleanup, such as nozzles, on the roof will be allowed, and only with a suitable nonflammable solvent such as methylene chloride. Major cleaning of equipment shall be confined to the ground.

### 3.5 GUARANTEE

- A. The Contractor shall certify that the foam and coatings were applied in accordance with the manufacturer's recommended procedures. The Contractor shall submit an executed copy of the Guarantee before final payment.
- B. The Contractor shall furnish to the Owner a manufacturer's written guarantee, guaranteeing all materials and workmanship for a period not less than ten (10) years from date of final acceptance.
- C. The urethane foam and silicone coating system shall be guaranteed against

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

failures of workmanship and materials. Repair of the system, including materials and labor, shall be at no cost to the Owner.

- D. On expiration of the first year of the guarantee, the **COATING MANUFACTURER, FOAM MANUFACTURER AND CONTRACTOR** accompanied by the Owner, shall inspect the urethane foam and coating system to determine the condition of the roof.
  - E. Any repairs that are necessary shall be accomplished as stated in the guarantee. Any defects and corrections necessary, but not covered under the guarantee, shall be at the Owner's expense.
2. The coating manufacturer shall submit to the Owner a report stating the results of each inspection for the remaining period of the guarantee.

## Guide Specification

### Coal-Tar Elastomeric Membrane Multi-Ply Roofing

#### A. GENERAL

1. REFERENCES – ROOFING

ASCE-7 – American Society of Civil Engineers: Wind Uplift Requirements  
ASTM – American Society for Testing Materials  
FM – Factory Mutual  
IBC – International Building Code  
IEC – International Energy Code  
NAAMM – National Association of Architectural Metal Manufacturers  
NRCA – National Roofing Contractors Association  
SMACNA – Sheet Metal and Air Conditioning Contractors National Association, Inc.: Architectural Sheet Metal Manual

2. DESIGN CRITERIA

- a. Roof slope: New construction minimum 1/4" per foot in any direction; this includes cross-slopes and crickets. Re-roof minimum IBC 1/4" slope not required; zero slope variance.
- b. Crickets: Required to direct water to drains.
- c. Counter flashing: Minimum 8" above roof surface for all rooftop items and equipment.
- d. Equipment curbs: Tops level in all directions.
- e. Primary Roof Drains: Sump for 24" distance around drains (48" distance around drains in less than 1/8" slope in reroofing); caps slotted or screened to minimize foreign object entry. Cast iron drains and caps. All drains to receive lead flashing. All drains installed by local plumbing code.
- f. Walkway Pads: Not used except 6' X 6' area at high and low step-offs at each roof ladder.
- g. Roof Expansion Joints: Roof expansion joints shall be installed according to NRCA guidelines.
- h. Scuttles: Tops sloped to drain.
- i. Copings: Sloped towards roof minimum 1" across width for drainage; Standing seam profile coping.
- j. Insulation: Minimum 2-layer application with all joints staggered minimum 12"; show material types and thicknesses in specifications.
- k. Pipe Penetrations: Braced high and low to structure to prevent movement. Insulate from underside of deck, along laterals, then minimum 6" vertical below next elbow joint (or tangent) to reduce potential condensate drippage.
- l. Existing Roofs: All traffic upon, and work associated with, existing roof systems shall be done in methods, manners, and by personnel endorsed by the manufacturer of the existing roof. The in-effect warranties and

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

- m. integrity of the existing roof systems shall be fully maintained.
  - n. Pipe supports: Draw details to illustrate all project conditions.
  - n. No angle supports through roof plane; if necessary, use capped-off galvanized pipe supports that can be easily flashed and sealed.
  - o. All flashing shall be mechanically fastened with a termination bar a maximum of 6" on center and be a minimum of eight inches (8") above finished roof height.
  - p. Vertical wall counter-flashing shall have saw-cut reglet with receiver.
  - q. All vertical flashing seams shall be hot air welded and become part of manufacturer's twenty (20) year warranty.
  - r. Roofing system shall be watertight without depending on any metal flashing or coping.
- 3. MECHANICAL COORDINATION**
- a. Equipment mounted level; curb types and heights to achieve required minimum base flashing criteria.
  - b. Gas Equipment heights to achieve minimum 3" vertical clearance between roof surface and bottom of drip leg piping cap.
  - c. For safety, ease of maintenance, and to minimize damage to roof system components, no equipment locations within 5' of roof expansion joints and/or roof divider joints, vertical parapets; no equipment within 10' of roof edges.
  - d. Roof system thermal insulation values based on heating, ventilation and air conditioning (HVAC) system design and the minimum guideline of IEC.
- 4. ELECTRICAL COORDINATION**
- a. New Construction Only: Avoid using pitch pockets for conduit penetrations. Power for rooftop equipment shall be located inside the respective equipment curb and accessible per code criteria.
  - b. All pitch pockets in reroofing shall be manufactured out of stainless steel, have grout and 2-part sealant. Rain bonnets shall also be installed.
  - c. Cable TV Masts and Supports: Provide galvanized pipe penetrations, minimum 24" height above roof surface, capped and sealed, anchored high and low to building structure, with base flashing.
- 5. KITCHEN EQUIPMENT COORDINATION**
- a. Show all rooftop equipment, penetrations and roof-related details on Drawings.
  - b. Combine pipe penetrations in hooded enclosures for mechanical piping.
- 6. STRUCTURAL COORDINATION**
- a. Top-of-steel elevations to accomplish required slopes and drainage; consider camber on members to avoid trapping water.
  - b. Footing elevations at wet columns to allow for underground storm pipe slopes/inverts and bends.

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

- c. Supports at roof perimeters, equipment, and roof drain bodies.
7. **WARRANTIES**
- a. Roofing - Manufacturer: Project shall be installed in such a manner that the roofing material manufacturer will furnish a written twenty (20) year NDL type warranty with no exclusion for hail events containing hail stones up to and including four inches (4") from the date of substantial completion of the completed project. Manufacturer issuing warranty shall provide historical data supporting hail resistance.
  - b. Roofing - Contractor: The contractor, jointly with any subcontractors employed by him, shall guarantee the work required and performed under this contract will be free from defects in workmanship and materials, and that the building will be and remain waterproof for a five (5) year warranty period, after the Owner accepts the work as substantially complete. The warranty shall be in approved notarized written form, to obligate the contractor and his subcontractors, if any, to make good the requirements of the warranty.
  - c. Warranty repairs shall be performed by a certified installer. The repairs shall be performed in accordance with the manufacturer's written instructions and recommended procedures so as to not void the warranty. Repair of the system, including materials and labor, shall be done at no cost to the Owner.

**B. PRODUCTS**

- 1. All materials shall be certified as totally asbestos-free.
  - a. ROOF SYSTEMS: 3-ply built-up plus a coal-tar elastomeric finish membrane cap with flood coat and gravel surfacing, complying with UL Class A and ASCE-7 wind uplift criteria.
    - 1) Finish Membrane: The coal-tar elastomeric membrane (CTEM) shall be minimum 60 mil overall calendared thickness. The membrane shall be a high-performance elastomeric membrane incorporating a DuPont™ Elvaloy□ KEE (ketone ethylene ester), extended with coal-tar pitch and reinforced with polyester fibers, or approved equal. The coal-tar elastomeric membrane (CTEM) shall meet the following physical properties: Elongation 170%, ASTM D 412; Tensile Strength 1500 lbs/in<sup>2</sup>, ASTM D 412; Tear Strength 330 ppi, ASTM D 624; Density @ 70° F, 80 lbs/ft<sup>3</sup>; Low Temperature Flexibility, Pass, 37-GP-56M; and Water Absorption less than 0.1%, 37-GP-56M.
    - 2) Base Flashing: Shall be same material as the coal-tar elastomeric finish membrane (CTEM) and be installed using the design principles set forth in the National Roofing Contractors Association Manual and details included in Specifications.
  - b. FELTS: Shall be Underwriters Laboratory approved and listed in the FM Global Approval Guide and shall be Type IV fiberglass ply sheet, Underwriters Laboratory Type G-1, meeting Federal Specification No.

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**

- SS-R-620B, ASTM D 2178, Type III, as manufactured by Johns-Manville, or approved equal.
- c. **FASTENERS:** Fasteners and fastening plates or bars shall be listed in the FM Global Approval Guide, and be as recommended by the fastener manufacturer for the specific application.
  - d. **BITUMEN:** ASTM D-312, Type IV extra steep asphalt.
  - e. **INSULATION:** Shall meet IEC requirements.
    - 1) First layer: Rigid closed-cell polyisocyanurate; long term thermal resistant R-value, FM Class I fire hazard classification, UL classified for installation with Class A roof covering.
    - 2) Second layer: Rigid asphalt impregnated on six sides fiberboard, UL classified for installation with Class A roof covering. Provide additional factory-tapered boards (minimum 1/4" per foot slope) for crickets as shown on roof plan.
    - 3) Insulation requirements can be met using lightweight insulating fill with EPS to meet IEC requirements.
  - f. **EXPANSION JOINTS and DIVIDER JOINTS:** Shall be as recommended by NRCA.
  - g. **EQUIPMENT SUPPORTS:** As recommended by both the roof system manufacturer and the equipment manufacturer.
  - h. **PIPE SUPPORTS:** Non-ferrous, non-corrosive type as recommended by roof manufacturer for proper pipe support and weight distribution on roof; supports shall provide unbinding thermal expansion/contraction movement of piping without jeopardizing warrant ability of roof system. Set supports on additional wearing surface of cap sheet layer or walk-pad material.

**C. EXECUTION**

- 1. **GENERAL INSTALLATION**
  - a. Maintain end-of-workday watertight building conditions on all re-roofing projects on existing facilities. Contractor shall be solely responsible for all damage occurring due to failure to properly seal building.
  - b. Install only as much roofing insulation as can be covered with roofing during the same work period.
  - c. Clean completed roof of all construction debris.
  - d. At roofing projects for existing buildings, all debris shall be removed from the grounds at the end of the day.
  - e. Test cuts should be performed only where there is reason to suspect that less than proper installation procedures have been used or materials have been shorted.
  - f. Copper and aluminum flashings and gravel stops are discouraged due to excessively high cost and possible problems related to vandalism.
  - g. IBC requirement of a minimum slope of 1/4" per foot in new construction shall be achieved by sloping the deck and not through tapered insulation. Tapered crickets are, however, encouraged to move water to drains.

## Design Criteria

### Division 7 – Thermal and Moisture Protection

- h. In reroofing projects, the design standard of 1/4" slope is not required and drainage of roofs shall be accomplished, where needed, with appropriately placed drains and overflow scuppers or gutters and downspouts rather than merely sheet flow to scuppers or over-the-side onto walls.
- i. All roof drainage shall be collected in an underground drain system and diverted away from the building. No drainage onto walls from adjacent roof areas shall be permitted except under emergency overflow conditions.
- j. All multi-level roofs shall have permanently attached ladders between levels with height differentials of 48 inches or greater.
- k. Do not change the design standard and system selected without prior approval.
- l. Comply with governing state, and federal regulations, safety standards, and codes.

**Design Criteria**  
**Division 7 – Thermal and Moisture Protection**





# APPLICATION FOR ACCEPTANCE OF ROOFING SYSTEM

CONTACT INFORMATION:

INDEX NUMBER:

|                                     |                 |          |
|-------------------------------------|-----------------|----------|
| ROOFING CONTRACTOR (NAME & ADDRESS) | TELEPHONE NO.:  | FAX:     |
|                                     | E-MAIL ADDRESS: | CONTACT: |
| CLIENT (NAME & ADDRESS)             | TELEPHONE NO.:  | FAX:     |
|                                     | E-MAIL ADDRESS: | CONTACT: |

**OVERVIEW OF WORK:** *(Submit 1 form per roof area)*

|  |       |                              |        |
|--|-------|------------------------------|--------|
| Building Name & Number:  |       |                              |        |
| Building Dimensions: Length:   | ft/m; | Width:                       | ft/m.; |
|  |       | Height                       | ft/m.  |
| Roof Slope:  |       |                              |        |
| Parapet Height ,max (in./m):   |       | Parapet Height ,min (in./m): |        |
| Type of Work: <input type="checkbox"/> New Construction <input type="checkbox"/> Recover (New roof over existing Roofing System) |       |                              |        |
| <input type="checkbox"/> Reroof (New cover/remove existing roofing system to deck) <input type="checkbox"/> Other                |       |                              |        |
| <b>FM Approved RoofNav Assembly Numbers:</b>   |       |                              |        |

**ROOF SURFACING:**

|   |  |
|---|--|
| <input type="checkbox"/> None   |  |
| <input type="checkbox"/> Coating                                      | <i>(Trade Name/Application Rate)</i>   |
| <input type="checkbox"/> Granules                                     | <i>(Application Rate)</i>  |
| <input type="checkbox"/> Gravel/Slag                                  | <i>(Application Rate)</i>  |
| <input type="checkbox"/> Ballast: <input type="checkbox"/> Stone Size | <input type="checkbox"/> Pavers <i>(Beveled or square edge);</i> <input type="checkbox"/> Other: |
| Ballast Weight (psf): Field:  | Perimeter: Corners:  |

**ROOF COVER/MEMBRANE:**

*(Please provide ALL applicable details including trade name, type, number of plies, thickness, reinforced, adhesive)*

|   |   |
|---|---|
| <input type="checkbox"/> Panel:                 | <input type="checkbox"/> Through Fastened Metal   |
|   | <input type="checkbox"/> Standing Seam metal  |
|   | <input type="checkbox"/> Fiber Reinforced Plastic (FRP)   |
|   | <input type="checkbox"/> Other:   |
| <input type="checkbox"/> Built Up Roofing (BUR) |   |
| <input type="checkbox"/> Modified Bitumen       |   |
| <input type="checkbox"/> Single Ply:            | <input type="checkbox"/> Adhered <input type="checkbox"/> Fastened <input type="checkbox"/> Ballasted |
| <input type="checkbox"/> Spray Applied          |   |
| <input type="checkbox"/> Other:                 |   |

**BASE SHEET:**

*(Please include Trade Name, Type, and Width)*

|  |  |
|--|--|
| <input type="checkbox"/> None                |  |
| Trade Name:                                  | Width: <input type="checkbox"/> 36 In. <input type="checkbox"/> 1 meter (39 In.) |
| <input type="checkbox"/> Fastened            | <input type="checkbox"/> Adhered   |
| <input type="checkbox"/> Secured per RoofNav | <b>OR</b> <input type="checkbox"/> Per FM Global Loss Prevention Data Sheet 1-29 |
| Comments:                                    |  |
| <input type="checkbox"/> Air Retarder        |  |
| <input type="checkbox"/> Vapor Retarder      |  |

**INSULATION**

| Layer   | Trade Name | Thickness (In.) | Fastened                 | Adhered                  | Tapered                  |
|---------|------------|-----------------|--------------------------|--------------------------|--------------------------|
| 1. Top  |            |                 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Next |            |                 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Next |            |                 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Next |            |                 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

|  |   |
|--|---|
| <input type="checkbox"/> Glass Fiber/Mineral Wool/Batt | <input type="checkbox"/> Facer Type/Vapor Barrier |
| <input type="checkbox"/> Thermal Barrier               |   |
| <input type="checkbox"/> Other:                        |   |
| <input type="checkbox"/> None                          |   |



# APPLICATION FOR ACCEPTANCE OF ROOFING SYSTEM

**DECK:**

(Please include manufacturer, type, yield strength, thickness/gage, etc.)

|   |   |
|---|---|
| <input type="checkbox"/> Steel:   |   |
| <input type="checkbox"/> LWIC (Form Deck):  | <input type="checkbox"/> Cementitious Wood Fiber: |
| <input type="checkbox"/> Concrete: <input type="checkbox"/> Pre-cast panels or <input type="checkbox"/> Cast in Place |   |
| <input type="checkbox"/> Wood   |   |
| <input type="checkbox"/> Fiber Reinforced Cement  | <input type="checkbox"/> Fiber Reinforced Plastic |
| <input type="checkbox"/> Gypsum: <input type="checkbox"/> Plank   | <input type="checkbox"/> Poured                   |
| <input type="checkbox"/> Other:   |   |
| Comments:   |   |

**ROOF STRUCTURE (Include Size, Gage, Etc.):**

|   |            |          |
|---|------------|----------|
| <input type="checkbox"/> Purlins <input type="checkbox"/> "C" OR <input type="checkbox"/> "Z"   |            |          |
| <input type="checkbox"/> Joists <input type="checkbox"/> Wood OR <input type="checkbox"/> Steel |            |          |
| <input type="checkbox"/> Beams <input type="checkbox"/> Wood OR <input type="checkbox"/> Steel  |            |          |
| <input type="checkbox"/> Other:   |            |          |
| Spacing: Field:   | Perimeter: | Corners: |
| Comments:   |            |          |

**FASTENERS USED IN ROOF ASSEMBLY:**

|   |                     |                   |
|---|---------------------|-------------------|
| <b>Roof Cover Fasteners:</b> Trade Name:  | Length:             | Diameter:         |
| Stress Plate/Batten:                      |                     |                   |
| Spacing: Field: <b>X</b>                  | Perimeter: <b>X</b> | Corners: <b>X</b> |
| <b>Insulation Fasteners:</b> Trade Name:  | Type:               |                   |
| Size:                                     | Stress Plate:       |                   |
| Spacing: Field:                           | Perimeter:          | Corners:          |
| <b>Deck Or Roof Panels Fasteners:</b>     | Type:               |                   |
| Trade Name:                               | Size Washer:        |                   |
| Length:                                   |                     |                   |
| If Weld: Size:                            | Weld:               | Washer:           |
| Deck Side Lap Fasteners: Field: <b>X</b>  | Perimeter: <b>X</b> | Corners: <b>X</b> |
| Spacing: Field: <b>X</b>                  | Perimeter: <b>X</b> | Corners: <b>X</b> |
| <b>Base Sheet Fasteners</b>               | Type:               |                   |
| Trade Name:                               | Length:             |                   |
| Head Diameter:                            |                     |                   |
| Spacing: (Attached Sketches as necessary) |                     |                   |
| Spacing Along Laps: Field:                | Perimeter:          | Corners:          |
| No. Intermediate Rows: Field:             | Perimeter:          | Corners:          |
| Spacing Along Intermediate Rows: Field:   | Perimeter:          | Corners:          |

**PERIMETER FLASHING:**

(Attach a detailed sketch of metal fascia, gravel stop, nailer, coping, etc.)

|   |  |
|---|--|
| <input type="checkbox"/> FM Approved Flashing | <input type="checkbox"/> Per FM Global Loss Prevention Data Sheet 1-49 |
| <input type="checkbox"/> Other:               | Comments:  |

**DRAINAGE:**

|  |
|--|
| For new construction: Has roof drainage been designed by a Qualified Engineer per FM Global Loss Prevention Data Sheet 1-54 and the local building code? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)   |
| For re-roofing and recovering: will the roof drainage be changed from the original design (for example: drain inserts, drains covered or removed, new expansion joints, blocked or reduced scupper size)? <input type="checkbox"/> Yes <input type="checkbox"/> No<br>If yes, were the changes reviewed by a Qualified Engineer? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details) |
| Is secondary (emergency) roof drainage provided per FM Global Data Sheet 1-54? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)   |

Signature of Property Owner: \_\_\_\_\_

Title: \_\_\_\_\_ Date: \_\_\_\_\_

Signature of Installing Contractor: \_\_\_\_\_

Title: \_\_\_\_\_ Date: \_\_\_\_\_



# APPLICATION FOR ACCEPTANCE OF ROOFING SYSTEM

## FM Global OFFICE REVIEW

(Please leave blank for FM Global Office Review)

### WIND:

|                                       |  |
|---------------------------------------|--|
| Design Wind Speed: _____ (mph)        | Ground Terrain: <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| Uplift Pressure in field: _____ (psf) | Uplift Rating Required:  |
| Adequate Uplift Rating Provided:      | Adequate? <input type="checkbox"/> Yes <input type="checkbox"/> No                               |

### FIRE:

|  |   |
|--|---|
| Internal Assembly Rating: <input type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Non-Combustible                   |   |
| External Fire Rating: <input type="checkbox"/> Class A <input type="checkbox"/> Class B <input type="checkbox"/> Class C <input type="checkbox"/> None |   |
| Concealed Spaces? <input type="checkbox"/> Yes <input type="checkbox"/> No   | Sprinklers below Roof? <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Adequate? <input type="checkbox"/> Yes <input type="checkbox"/> No   |   |

### HAIL:

|   |   |
|---|---|
| Hail Rating Needed? <input type="checkbox"/> SH <input type="checkbox"/> MH <input type="checkbox"/> None | Hail Rating Provided? <input type="checkbox"/> SH <input type="checkbox"/> MH <input type="checkbox"/> None |
| Adequate? <input type="checkbox"/> Yes <input type="checkbox"/> No  |   |

### COLLAPSE:

|  |
|--|
| If standing seam, has collapse been reviewed? <input type="checkbox"/> Yes <input type="checkbox"/> No |
|--|

### COMMENTS:

Reviewed By: \_\_\_\_\_

Date: \_\_\_\_\_

### FM Global Field Review:

(Leave blank for on-site review by FM Global Loss prevention Consultant):

System installed per reviewed/accepted plans?  Yes  No

If no, explain:

Installation witnessed by FM Global?  Yes  No

Uplift test needed?  Yes  No

*(Uplift testing is REQUIRED for applicable new and recover roofs in hurricane, typhoon or tropical cyclone prone regions (see DS 1-29 and 1-52 for more information))*

Uplift testing satisfactorily completed  Yes  No  DNA

If yes, note pressures held for the: Field \_\_\_\_\_ Perimeter \_\_\_\_\_ Corners \_\_\_\_\_

If no, explain and provide required and obtained uplift pressures and other details and attach to this form.

Reviewed By: \_\_\_\_\_

Date: \_\_\_\_\_



## General Information

Building fenestration shall comply with State Energy Code, ASHRAE 90.1-2010, including assembly U values, assembly SHGC and percentage of glass.

Ensure that windows, doors, and louvers are designed for adequate wind loading and velocity pressures per International Building Code and Texas Windstorm requirements as applicable.

All general use building entrances shall have a vestibule. At least one door at primary entrances shall be power operated. Primary entrances shall be designated by the User Coordinator and Facilities Department.

Doors may be sliding or swinging, as appropriate to the building use and design, with safeguards and handicapped accessibility as necessary. One-way or two-way types may be used, depending upon traffic. Door types, materials, hardware, and sensors shall be established designs with proven field experience under similar usage. Consideration shall be given to availability of trained service technicians and spare parts.

One or more entrance doors may require card key access. These entrances shall be selected by the User Coordinator. The door frames shall be prepped as a part of the design and construction of the building. The card key devices shall be acquired by the Campus and delivered to the Contractor for installation or installed by the Facilities Department.

The use of daylighting in the building design is strongly encouraged. Use of skylights is not allowed unless approved in writing by the Facilities Department. Use of protected clerestory glazing is allowed.

Warning bars or cross mullions shall extend across all full height glazed areas. Meet requirements of "Model Safety Glazing Code" and "Consumer Product Safety Commission."

For coastal campuses with 3sec wind gusts > 110 mph (Galveston, Kingsville, Corpus Christi), install Large Missile Impact Resistant Laminated Glass, especially for large openings (>20sq.ft.) where shutters cannot be installed, or over 100% of openings on critical or high-value buildings, or for multistory buildings, install at heights above 60ft.

Ensure the systems are satisfactorily tested per Florida Building Code Testing Application Standards (TAS) 201, 202, and 203, or ASTM Standards E1886 and E1996.

To search for Miami-Dade (Building Code Compliance Office) approved products on the web, see: [www.miamidade.gov/buildingcode/pc-search\\_app.asp](http://www.miamidade.gov/buildingcode/pc-search_app.asp)

Windstorm shutters may also be used to protect windows against flying debris and high inward/outward pressures if they are permanently installed, or can be installed campus-wide within 8hrs of arrival of an approaching storm. Shutters should be capable of withstanding the inward/outward pressures. Miami-Dade County Approved Products are preferred.

At minimum following information shall be part of the parametric data associated with door frames and doors: room number (automatically assigned), frame material, door material, frame finish, door finish, frame gauge, door gauge, hardware listed individually not by set, fire rating, door swing.

## **Doors and Frames**

Exterior and interior personnel doors shall not be taller than 7 feet high unless approved by the Facilities Department.

All entrance doors and frames shall be hinge and strike reinforced for “High Frequency” use.

Hollow Metal Exterior Doors shall be not less than 16 gauge with 14 gauge or heavier one piece welded frame. Door and frame shall be A60 galvanized.

Interior Hollow Metal Doors shall be not less than 18 gauge with 16 gauge one piece welded frame.

Interior wood doors shall be at least 1-3/4” thick to accommodate mortise locks.

Interior wood doors are generally flush type, solid core, hardwood with lifetime warranty. Wood doors can be either wood veneer or plastic laminate faced. Exotic wood veneers are prohibited.

## **Entrances, Storefronts and Curtainwalls**

Metal framed glazed entrance assemblies shall have stiles of sufficient width to receive mortise locksets and/or panic hardware. Custom styled doors with vision panels may be used. Locksets shall be at conventional height and shall not be permitted in bottom rails. Bottom rail shall be a minimum of 12 inches and top rail shall be a minimum of 6 inches.

Wherever possible utilize storefront systems instead of curtainwall systems.

Include in specifications, steel reinforcing inserts in the hinge jamb section of doors in aluminum storefront systems.

Color of storefront, curtainwall and window frames shall match the campus standard.

## Windows

Heads, jambs, and sills of windows in walls shall be flashed and shall be caulked or sealed during the window installation, prior to the placement of snap-on moldings or covers, to ensure that concealed surfaces are properly sealed against the penetration of wind and water. Flashing shall include pre-molded end dams. All windows should have drips at heads and sills.

Projected and casement type windows, and flush mounted windows are difficult to maintain watertight and their use is discouraged.

Design windows with maintenance in mind and include provisions for cleaning windows above third floor.

## Hardware

The hardware schedule shall be included in the project specifications.

A minimum of one pair of exterior double doors shall have a keyed, removable mullion for equipment access.

Use thresholds and weather stripping at exterior doors to prevent air and water infiltration.

Specify all finish hardware. Locksets will be by the manufacturers' below and for the most part shall be heavy duty mortise type with key removable core cylinders (except at Tarleton). Locksets shall accept interchangeably the cores and cylinders from the manufacturer(s) below

All doors leading into hazardous spaces, mechanical, electrical and telecommunication rooms shall have a textured surface on the door lever.

All doors at wet and high humidity areas such as kitchens, shower rooms, mechanical rooms, etc. shall have a brass or bronze (non-ferrous) base metal hinge or stainless steel hinge.

Contractor shall execute construction core agreement with Locking Systems Supplier prior to shipment of permanent cores.

Satin chrome plated finish is generally used.

Door closers by LCN, Norton or Sargent are acceptable; hinges by McKinney, Hager, Lawrence, or Stanley are acceptable; equal quality hardware of other manufacturers will be acceptable.

Specify plated hinges only for doors receiving a natural or transparent finish; specify prime coated hinges for painted doors.

Specify ball bearing or oilite bearing hinges only on doors which receive closers. Non-removable pin hinges for out swinging exterior doors and other "secured" areas. Specify closers generally for exterior doors, doors in fire-rated walls, and toilet room doors. Special laboratory conditions or other special room function may require use of closers on doors.

All doors having closers should be protected from wear of wheelchairs by a minimum of 10" high kickplates.

Do not specify pivot hinges or concealed closers.

The A/E shall investigate the security requirements for the project and develop an appropriate keying system. The specifications shall call for two (2) keys for each lockset, One (1) control keys along with an appropriate quantity of grandmaster, master and sub-master keys to be provided. A Bitting Schedule and set number of key blanks will also be required. Final keying functions shall be established during a key conference conducted by FPC, with the A/E, User, Facilities Department, Contractor, and successful hardware supplier during construction.

Verify other requirements such as extra key blanks, key box, etc. with User and Facilities Department.

Concealed rods on exit devices are not allowed.

## **Glazing**

High performance glazing is strongly encouraged with a tint to match surrounding buildings. Highly reflective (mirror) glass and dark tinted glass are not allowed.

Partial shading of insulating glass can cause stress breakage. Manufacturers consider this to be a design error and will not replace glass broken by temperature differential stresses. Avoid partial shading of large panes.

Provide manufacturer's written guarantee that for ten years from date of Substantial Completion a replacement will be provided for any insulated glass unit which develops edge separation or other defects which materially obstruct vision through the glass or safety or affects the insulating qualities. Guarantee shall not cover glass breakage from physical abuse, storm or similar causes.



## Specific Campus Requirements

### Texas A&M University

Building fenestration shall comply with ASHRAE 90.1-2010, including assembly U values, assembly SHGC and percentage of glass.

### Hardware

Always verify hardware specification with TAMU Building Access Department

#### Hinges

All hinges shall be full mortise template five-knuckle, 4-1/2 inches high as manufactured by Hager, McKinney or Stanley. Use Non Removable Pin (NRP) feature on all exterior doors that swing out. Use the proper hinge width as determined by the clearance required.

Exterior doors over 36 inches and all primary entrance/exit doors. Use heavy weight, four bearing, stainless steel hinges with 630 finish.

All other exterior doors. Use standard weight/medium frequency, two bearing stainless steel hinges with 630 finish.

Interior doors over 36 inches, all corridor doors, and doors with closures - Use heavy weight four bearing, steel hinges with 652 finish.

All other interior doors - Use standard weight medium frequency, two bearing steel hinges with 652 finish.

#### Locksets

Mortise locks shall meet ANSI A256.13 Series 1000, Grade 1 Operational and Grade 2 Security. Listed by Underwriters laboratory for use on 3 Hour A label doors. Lock case and face plate dimensions fit standard door preparation as specified in ANSI A115.1. Locksets and Latch-sets must have the ability to change handling without opening the case. Other requirements are as follows:

Satin stainless steel No. 626 or 630 finish.

One inch stainless steel throw deadbolt.

3/4 inch throw anti-friction latch bolt standard.

Quick re-keying with interchangeable core small format.

Solid lever trim with return.

3 year published limited warranty.

Furnish all locksets with 7-pin interchangeable core cylinders. Acceptable locksets are:

- Best 45H - 15H
- Sargent 8200 –LW1L
- Falcon MA series - DN

**Cylinders**

Cores shall be manufactured by “Medeco Security Locks” and shall be an extension of the existing A2 master key system using interchangeable Medeco x4 EFV cores. Use Medeco interchangeable core cylinder housing 33076021-Z02 with security collar 94-0151 on exterior aluminum doors that have Adams Rite Locksets, 2 year published warranty.

All Medeco keys provided to Texas A&M University, be they factory cut keys or key blanks shall be custom coined with approved Texas A&M logo. Utilize Medeco coining die #D353.

The TAMU Building Access Department will be responsible for changing out the construction cores with the permanent cores and for returning construction cores to building Contractor.

**Exit Devices**

Devices shall be Satin stainless steel finish No. 630. Other requirements are:

Narrow stile exit devices only where the door stile dimension requires.

Use mortise exit devices only where a pair of doors cannot have a removable mullion. Use on the active leaf with a surface mounted device on the inactive leaf.

Five year mechanical warranty and one year electrical warranty.

Device to be equipped with lever. Acceptable exit devices are:

|                        | Von Duprin | Sargent     | Precision    |
|------------------------|------------|-------------|--------------|
| Rim Mounted            | 98         | 8813 ETL    | 2108         |
| Rim Mounted, Fire      | 98F        | 12-8813 ETL | FL2108-4908A |
| Surface, Vertical      | 9827       | 8713 ETL    | 2208-4908A   |
| Surface Vertical, Fire | 9827F      | 12-8713 ETL | FL2208-4908A |

|                         |        |                |              |
|-------------------------|--------|----------------|--------------|
| Mortise                 | 9875   | 8913 ETL       | 2308-4908A   |
| Mortise, Fire           | 9875F  | 12-8913 ETL    | FL2308-4908A |
| Removable Mullion       | KR4954 | 980 (Steel)    | PR-822       |
| Removable Mullion, Fire | KR9954 | 12-980 (Steel) | FL-822       |

Doors where electronic access is required and magnetic locks are going to be used shall include an internal signal switch to break lock power. Only Sargent 88 series or Von Duprin QUE-99 series electric panics are acceptable wherever electric panics are specified.

### Doors Closers

Door closer will have a heavy duty cast iron cylinder with all-weather hydraulic fluid, 10 year warranty, painted aluminum finish, UL listed for use on fire-rated doors, separate back check, sweep speed, and latch speed regulating valves, fully adjustable. LCN 4040 Series, Sargent 1430, Sargent 1431 (handicapped) are acceptable.

Any substitution or alternates will need to be approved by the campus Facilities Department, Facility Maintenance and Renovation Division. Approval process will begin with FPC Project Manager.

## **Tarleton State University**

### **Doors**

Hollow Metal Door Frames: Curries or Ceco SU series, unequal rabbit, 16 gauge  
Hollow Metal Doors: Curries 607 (light weight, interior) 18 gauge face skin  
Curries 747 (heavy weight, exterior and stairwells) 16 gauge face skin and 20 gauge stiffeners  
Ceco Door Medallion or Trio (same as Curries)  
Wood Doors (solid core): VT Industries 5502 (top and bottom rails 1-3/8", vertical stiles 1-3/8")  
Mashefield Signature Series (plain sliced red oak flush, clear 0-05 finish)  
Aluminum Storefront: Special Lite SL-15 Monumental  
1/4" bronze tempered glass (exterior)  
1/4" clear tempered glass (interior)  
SL-484 12" FPR Mid-panel  
SL-88 recessed pull  
10" bottom

### **Hardware**

#### Hinges

Ives  
Hager BB1279 or BB1168  
McKinney

Use heavy weight hinges for restroom and classroom doors

### Gear Hinge

McKinney  
Select SL24HD

Full mortise, continuous and dark bronze

### Locksets

Sargent T-Zone Non removable cores

Office: 28-11G05-LL-10B (keyway as specified)  
Passage: 28-11G15-LL-10B

### Exit Devices

Hollow Metal Doors: Sargent 8800 Series

Cylinder Dogging (16-prefix) when Electric Latch Retraction  
(56-prefix) is not necessary for card reader  
Standard : 16-8813-ETL-TB-(hand)-10B

Aluminum Storefront:

Von Duprin  
EL-RXCD99NL-OP x 110NL (with card reader)  
RX  
330 (dummy panic hardware)

No vertical rods (concealed or surface mounted) for Exit Devices on aluminum storefront doors.

### Closers

LCN 4041 (standard duty) or 4110 (heavy duty) dark bronze  
PA Shoe (62PA) required for parallel arm mounting

### Automatic Door Opener

Power Access 4300 Series, pushbutton CE-635 BSM

### Hardware Accessories

|                    |   |
|--------------------|---|
| Kick Plates:       | Ives, Rockwood, Trimco                              |
| Overhead Stop:     | Glynn Johnson 100 Series (if necessary)             |
| Wall Stops:        | Ives, Hagar (concave rubber bumper) US10B finish    |
| Door Silencer:     | Ives SR64 (grey or tan)                             |
| Threshold:         | National Guard Product 896DKB (exterior)            |
| Sweep:             | National Guard Product 200UDKB                      |
| Weather Stripping: | National Guard Product 160VDKB vinyl perimeter seal |

## **Prairie View A&M University**

### **Hardware**

Best or Falcon removable cores (except Sargent locks on mechanical and equipment rooms)

## **Texas A&M University at Galveston**

### **Hardware**

Sargent removable cores

## **Texas A&M University - Corpus Christi**

### **Hardware**

All primary entrance doors shall be horizontal sliding

Service entry doors and frames shall be fiberglass construction

### **Hinges**

Full mortise template hinges, five-knuckle type, plain bearing except at doors with closers or doors over 40 inches width furnish ball bearing type.

Non-removable pin at exterior doors. Non-ferrous hinges at exterior doors. 630 finish.

Furnish quantity of hinges per door as follows:

Doors up to 90 inches in height - 3 butts. Doors over 90 inches and less than 120 inches in height - 4 butts.

Furnish hinge sizes as follows for 1-3/4 inch doors:

Up to 3'-0" wide, - 4-1/2 x 4-1/2.

Over 3'-0" to 3'-4" wide - 5 x 4-1/2.

Over 3' - 4" wide - extra heavy 5 x 4-1/2.

Width of hinges adjusted as required to clear adjacent to.

Doors over 1-3/4" thick to receive heavy weight.

Hager, Stanley, McKinney, Lawrence or equal.

### Aluminum Geared Hinges

Hagar – Roton

Pemko

ABH Mfg.

Select

### Stainless Steel Hinges

Hagar – Roton

Markar

ABH Mfg.

Select

### Locksets

Qualities: Mortise locksets, function as listed on schedule (function identification numbers of BHMA-PS). Backsets and strike types as required by conditions. Furnish with construction key system. All locks to accept Primus interchangeable removable core cylinders.

Standard: ANSI A156.2, Series 4000 Grade 1. 626 Finish.

Source: Schlage D Series Rhodes.

### Exit Devices

Wood and hollow metal doors: Von Duprin 88 Series with push trim or Sargent 9800 Series.

### Door Closers

Fully hydraulic, full rack and pinion action high strength cylinder. Furnish complete with forged steel arms, necessary brackets and fasteners. Top of door mounting. Provide parallel arms at exterior doors. Provide hex nuts and bolts on wood doors. Provide necessary brackets and plates for complete working application. Furnish other scheduled accessories. Provide non-handed closers at doors requiring handicapped opening force requirements. Size closers in accordance with manufacturer's directions.

Standard: ANSI A156.4, Series 2000.

Source: LCN 1460/4040

## **Texas A&M International University**

### **Hardware**

Best removable cores

## **Texas A&M University-Kingsville**

### **Hardware**

Best 7 pin removable cores

## **West Texas A&M University**

### **Hardware**

#### **Hinges:**

All hinges shall be full mortise template hinges, 5 knuckle type, heavy-duty ball bearings, and 3-4 ½ inch butts per door.

Roton continuous hinges are to be used on all external doors and doors with special application i.e. abnormal weight or high volume usage. Finish on all hinges is to match other hardware on door, and existing surrounding hardware.

Hager Hinge Co. and Stanley Hardware are approved for butt style hinges.

Spring loaded hinges are to be used on approved doorways. PBB World Class Hinges, model number SP81 or other approved manufacturer are to be used.

#### **Locksets:**

All locksets shall be heavy-duty, Schlage “ND” Rhodes.

All exterior access with hard key shall be interchangeable core design locks.

All hardware installed during a remodel or new construction shall match finish with existing hardware or as so specified in new construction guidelines.

**Cylinders:**

Schlage maintains and expands WTAMUs master key system.

Contractors shall furnish information on cylinders to Schlage i.e. Cylinder design- Rim, Mortise, Key in Lever, etc.

Levels of master keying shall be coordinated through the WTAMU Lock Shop. A copy of the Lock/Key order shall be provided to the Lock Shop prior to the order being sent to Schlage by the contractor.

**Exit Devices:**

All exit devices shall be Arrow S3800 series, Sargent 80 series, or Von Duprin 98/99 series or approved series via the WTAMU Lock Shop.

Any panic device that is keyed access shall use Interchangeable Core (IC) cylinders.

Panic devices that have dogging mechanisms shall use I.C. cylinders.

On double doors that incorporate center mullions: the center mullion shall be key removable with I.C cylinders.

**Electronic Access:**

Any electric strikes shall be H.E.S. 9600 series, 5000 series or a model approved by WTAMU Lock Shop.

NO electrified Locksets will be accepted unless first approved by the Lock Shop. Finish should match surrounding door treatments.

**Closers:**

All door closers shall meet TAS and ADA requirements.

Approved closer: LCN model #4041

Closers shall be installed with H-EDA arms or 3049 EDA arms or other approved arms per application.

**Power Operators:**



Any automatic door opening systems should be a Stanley Magic-Force, Nabco Model 710 Swing Door System or LCN 4630/4640 Electric Auto-Equalizer Series

Any variations shall be approved by the WTAMU Lock Shop

## **Texas A&M University - Commerce**

### **Hardware**

Locksets: Best or Sargent

Cores: Best

## **Texas A&M University-Texarkana**

### **Hardware**

Hinges – Full mortise, button tipped, ball bearing. Interior hinges primed for paint, USP. Exterior hinges, satin finished stainless steel, US32D

Lockset – Heavy duty mortise lockset with cast lever and rose trim. Finish: US32D satin stainless steel at exterior openings; US26D satin chrome plated at interior openings. Provide Best interchangeable cores, MX8 patented keying system.

Hardware accessories – Match lockset finish.



## General Information

The preliminary selection of interior finish materials shall take place during the schematic design phase. During the design development phase the A/E's Interior Designer shall present a minimum of two distinct color schemes to the User Coordinator and FPC Project Manager. A final color scheme will be selected and incorporated into the specifications.

Interior finish materials shall be high quality, durable materials that are easily maintained and manufactured regionally. Particular attention shall be given to finishes in public spaces. The use of materials with recycled content is encouraged.

Avoid the use of imported, costly or high maintenance materials. Finishes or detailing that have minimal tolerances and place unrealistic expectations on the installing contractor(s) shall be avoided.

Verify attic stock quantities of interior finish material with Member Facilities Department.

## Gypsum Wallboard

All interior gypsum wallboard should be at least a DensArmor or DensArmor Plus or equal mold resistant wallboard.

All gypsum wallboard, regardless of location, shall be not less than 5/8".

## Tile

The use of ceramic tile is encouraged for high profile/high use public areas, restrooms, shower and locker rooms or other spaces where a durable material is appropriate. Avoid dark colors and extremely light colors for tiles. Avoid white or light colored grout for floor applications.

Consider the use of tile or other durable material as wainscot on high traffic corridor walls especially near classrooms.

All floor tiles shall be non-slip and rated for heavy duty use.

Designs where floor and wall tile indicate a pattern of colors or a "mosaic" shall be detailed in the drawings using specific tile sizes dimensions and notes to clearly indicate the extent and complexity of the pattern or "mosaic".

All floor tile grout shall be sealed. In frequently wet areas such as showers, floor and wall grout shall be sealed. Grout shall match intended application.

## Suspended Acoustical Ceilings

All ceilings shall be designed to be easily accessible for maintenance and other access needs. A single type of ceiling tile such as 2 ft x 2 ft or 2 ft x 4 ft, minimum 5/8" thick, non-directional pattern tiles with a recycled content shall be used throughout a building to minimize maintenance and repair costs. Exceptions to this are special areas that are identified in the POR.

Ceiling suspension assemblies shall be supported directly from the building structure and shall be supported at all four corners of fluorescent light fixtures. Location of hangers shall not interfere with access to VAV filters, valves, dampers and other items requiring maintenance.

All ceilings shall be modeled at the assigned height in the BIMs.

Ceiling assembly systems, such as finished gypsum, suspended ceilings, or acoustic ceiling clouds, can require fire protection be provided both above and below, under the following circumstances:

The open space between the finished ceiling within the normally occupied space and the floor or roof above having concealed combustibles in construction (e.g. attics in apartments or student housing with combustible wooden boards & joist and shingled roof construction)

If a suspended acoustical ceiling cloud or other ceiling-level installation results in an "obstructed ceiling construction." The definition of "Obstructed" verses "Unobstructed" are defined as:

*UNOBSTRUCTED:* A ceiling construction or assembly that allows the flow of hot gases to spread out under the ceiling uniformly from the point of fire origin to the nearest four sprinklers in a timely fashion. Ceiling assemblies that meet this definition include:

Ceiling systems that have construction materials that do not protrude downward from the ceiling more than 4 in. (100 mm), or

ceiling systems that have construction materials that protrude downward from the ceiling more than 4 in. (100 mm) but their cross-sectional area is 70% or more open, or

ceiling systems that have construction materials that protrude downward from the ceiling more than 4 in. (100 mm) and are less than 70% open in their cross-sectional area, but the volume created by the ceiling structural assembly does not exceed 100 ft<sup>3</sup> (2.8 m<sup>3</sup>), or

the horizontal distance between the construction material protrusions exceeds

the maximum allowable spacing for the sprinkler being installed.

*OBSTRUCTED*: Ceiling assemblies that do not meet the above definition.

## **Terrazzo**

Use of terrazzo flooring where high traffic occurs is encouraged.

## **Carpet Systems**

Refer to Guide Specification at the end of this division.

## **Resilient Tile Flooring**

Vinyl composition tile shall be 1/8 inch thick with thru pattern or thru-chip construction and meets the requirements of ADA for static coefficient of friction when installed in accordance with manufacturer's guidelines. Recycled content (post-consumer and post-industrial waste) shall be minimum 10%. Material must meet or exceed 5 year warranty

Rubber flooring is also acceptable.

## **Vinyl Wall Covering**

The use of vinyl wall covering is discouraged especially on interior surface of exterior walls.

## **Painting and Coating**

Satin or semi gloss enamel paint shall be used on all surfaces and items normally painted. Flat finish paint is not acceptable. Minimum of two finish coats over a prime coat of a different tint than finish coat.

Manufacturers standard color selection shall be utilized. Avoid the use of deeply saturated colors for walls. The use of lighter colors is recommended since these colors enhance reflectivity and reduce the need for lighting. The selection of zero or low VOC products is required to eliminate problems with off-gassing.

Inside surface of wood cabinet drawers to receive two coats of clear sealer.

Top and bottom edges of wood doors to receive two coats of tinted sealer to aid visual inspection.

Except for prime coats on equipment and piping insulation, specify all field painting

under the painting section of the specifications.

The following colors shall be used for banding of all piping and conduits.

| <u>Service</u>                      | <u>Color</u> |
|-------------------------------------|--------------|
| Domestic Water, Cold or Hot         | Blue         |
| Chilled, Heating or Condenser Water | Green        |
| Natural Gas                         | Orange       |
| Air                                 | White        |
| Steam and Condensate                | Light Gray   |
| Electric Conduit                    | Yellow       |
| Drain Lines                         | Black        |
| Fire Water                          | Red          |

Each pipe circuit is to be marked by stencil. Stencil shall include flow arrow and identification mark as follows: At wall penetrations, machine or tank connections and at not over 50 feet intervals. Stick-on type or plastic wrap-on markers are not acceptable.

| <u>Service</u>                     | <u>Mark</u>   |
|------------------------------------|---------------|
| Domestic Water Supply              | Dom-W-S       |
| Domestic Hot Water Supply          | Dom-HW-S      |
| Domestic Refrigerated Water Supply | Dom-RW-S      |
| Chilled Water Supply (Air Cond.)   | Ch-W-S        |
| Chilled Water Return (Air Cond.)   | Ch-W-R        |
| Condenser Water Supply             | Cond-W-S      |
| Condenser Water Return             | Cond-W-R      |
| Heating Water Supply               | Ht-W-S        |
| Heating Water Return               | Ht-W-R        |
| Natural Gas                        | Nat. Gas      |
| Air (Pressure)                     | Air-Pressure  |
| Steam (Pressure)                   | St-Pressure   |
| Condensate                         | Cond          |
| Electric (Voltage)                 | Elect-Voltage |

## Campus Specific Information

### Texas A&M University

### Resilient Tile Flooring

All resilient tile flooring shall be cleaned and left unsealed by the contractor. The Facilities Department will seal and polish the floors.

## Tarleton State University

### Acoustical Ceiling

Grid: USG Donn DX (White)

Tile: USG Radar 2'x2', SLT edge (non-directional) white

## Texas A&M University-Corpus Christi

### Gypsum Wallboard

All interior wallboard shall be DensArmor Plus or equal.

## West Texas A&M University

Campus has Interior Finish Standard that will be supplied.

### Painting and Coating

The following colors shall be used for banding of all piping and conduits.

| <u>Service</u>      | <u>Color</u>                               |
|---------------------|--|
| Fire Water          | Red, equal to Kelly-Moore 5780-562.        |
| City Water          | Dark Green, equal to Kelly-Moore 5780-551  |
| Domestic Water      | Dark Green, equal to Kelly-Moore 5780-551. |
| Domestic Hot Water  | Light Green, equal to Kelly-Moore 5780-565 |
| Treated Water       | Beige, equal to Kelly-Moore Bone-27        |
| Brine               | Beige, equal to Kelly-Moore Bone-27        |
| Chilled Water       | Dark Blue, equal to Kelly-Moore 5780-564   |
| Condenser Water     | Light Blue, equal to Kelly-Moore KM299-M   |
| Heating Water       | Yellow, equal to Kelly-Moore 5780-563      |
| Utility/Control Air | White, equal to Kelly-Moore 5780-103       |
| Natural Gas         | Gray, equal to Kelly-Moore Rust-3086.      |
| Sewer/Drain         | Black, equal to Kelly-Moore 5780-568.      |
| Steam               | Dark Orange, equal to Kelly-Moore 5780-571 |
| Condensate Return   | Light Orange, equal to Kelly-Moore AC7-Y   |
| Boiler Feedwater    | Yellow, equal to Kelly-Moore 5780-563      |
| Freon/Refrigerant   | Tan, equal to Kelly-Moore 171 Sandpebble   |
| Vacuum              | White, equal to Kelly-Moore 5780-103       |

Each pipe circuit is to be marked by stencil. Stencil shall include flow arrow and

**Design Criteria**  
**Division 9 – Finishes**

identification mark as follows: At wall penetrations, machine or tank connections and at not over 50 feet intervals. Stick-on type or plastic wrap-on markers are not acceptable.

| <u>Service</u>            | <u>Mark</u>         |
|---------------------------|---------------------|
| City Water                | White-City Water    |
| Domestic Water            | White-Dom-W-S       |
| Domestic Hot Water Supply | White-Dom-H-W-S     |
| Domestic Hot Water Return | White-Dom-H-W-R     |
| Treated Water             | Black-Treated Water |
| Brine                     | Black-Brine         |
| Chilled Water Supply      | White-Ch-W-S        |
| Chilled Water Return      | White-Ch-W-R        |
| Condenser Water Supply    | White-Cond-W-S      |
| Condenser Water Return    | White-Cond-W-R      |
| Heating Water Supply      | Black-H-W-S         |
| Heating Water Return      | Black-H-W-R         |
| Utility/Control Air       | Black-Air           |
| Natural Gas               | Black-Nat Gas       |
| Sewer/Drain               | White-Sewer         |
| High Pressure Steam       | Black 90# Steam     |
| Low Pressure Steam        | Black 15# Steam     |
| Condensate Return         | Black-Cond Return   |
| Boiler Feedwater          | Black-Feedwater     |
| Freon/Refrigerant         | Black-Refrig        |
| Vacuum                    | Blue-Vac            |
| Decoupler                 | Decoupler           |

Use the following for letter sizing

| Outside of Diameter of Pipe or Covering In Inches | Length of Field In Inches | Height of Characters | Width of Principal Stroke |
|---|---------------------------|----------------------|---------------------------|
| Less than 3/4                                     | Use Tags                  | --                   | --                        |
| 3/4 to 1-1/4                                      | 8                         | 1/2                  | 1/8                       |
| 1-1/2 to 2  | 8                         | 3/4                  | 3/16                      |
| 2-1/2 to 6  | 12                        | 1-1/4                | 5/16                      |
| 8 to 10   | 24                        | 2-1/2                | 5/8                       |
| Over 10   | 32                        | 3-1/2                | 7/8                       |



## **Texas A&M University-Texarkana**

### **Resilient Tile Flooring**

All resilient tile flooring shall be finished by Contractor with 5 coats of Johnson Showplace wax.

### **Gypsum Wallboard**

All interior gypsum wallboard shall have a Level 4 finish, topped with light textured finish.

## Guide Specification

### Carpet Systems

#### 1.0 GENERAL

##### 1.1 SUMMARY

A. The following shall be used as a guide for a minimum carpet specification. Other products with equal or better characteristics or qualities shall be considered.

#### 2.0 PRODUCTS

##### 2.1 CARPET SYSTEMS

- A. Modular vinyl backed carpet tile or six foot roll carpet with vinyl back.
- B. Manufacturers: Interface, Lees, Mannington, Tandus C&A or acceptable substitute shall meet the following requirements:
  - 1. Construction: Textured or level loop tufted.
  - 2. Face Fiber: 100% Invista Antron Lumena® or Antron® Legacy, Antron Blend. Type 6,6 nylon - continuous filament with anti-soil, anti-stain protection.
  - 3. Pile Height:  $\geq 0.117$  and  $< 0.187$ .
  - 4. Yarn Weight: (varies depending on tuft gauge and pile height).
  - 5. Dye Method: 100% solution dyed or a solution dyed yarn dye blend.
  - 6. Stitches per inch: 12 minimum.
  - 7. Tuft Gauge: 1/13 inch (1/12 inch minimum).
  - 8. Primary Backing: 100% sealant vinyl or non-woven synthetic
  - 9. Secondary Backing: 100% vinyl back or 5/32 inch vinyl closed cell cushion back. Backing shall be fusion bonded to face fiber and primary backing to create an integrated product. Shall pass: Test ASTM D 3936 delaminating of secondary back, Test ASTM D 1667 with 25% deflection @710 PSI.

10. Density: 4500 minimum.
11. Electrostatic Propensity: 3.5 KV or Less.
12. Warranty: Lifetime – 20 years, non-prorated warranty against delaminating, edge ravel, zipping, moisture penetration, wear.

C. Performance Characteristics:

1. Flammability:
  - a. Radiant Panel Test (Direct Glue): ASTM E-648, Class 1.
  - b. Pill Test: pass Doc FF1-70.
  - c. Flaming Mode: <450 per ASTM E-662 NBS Smoke Density.
  - d. Non-flaming Mode: <450 per ASTM E-662 NBS Smoke Density.
2. Static: < 3.5 KV Permanent Conductive Fiber per AATCC-134.
3. Electric Resistance: pass NFPA 99.
4. Burroughs Method: pass NFPA 99.
5. U. S. Green Building Council LEED-NC 2.2, Indoor Environmental Quality, EQ Credit 4.3, Low-Emitting Materials, Carpet Systems:
  - a. All carpet installed in the building interior shall meet the testing and product requirements of the Carpet and Rug Institute's Green Label Plus Program or for which testing has been done by qualified independent laboratories in accordance with the appropriate requirements.
  - b. Any carpet cushion installed in the building interior shall meet the requirements of the Carpet and Rug Institute Green Label program.
  - c. All carpet adhesive shall meet the requirements of U. S. Green Building Council LEED-NC 2.2, EQ Credit 4.1: VOC limit of 50 g/L.
6. Recycled content: minimum 35%.
7. Recyclable: 100% of all content.

## 2.2 ACCESSORIES

- A. Carpet Adhesive: Releasable, pressure sensitive type adhesive shall be water based and allow for removal without damage to carpet or substrate and leave no residue.
- B. Adhesive Seam Sealer: (For 6 foot roll goods) As required, provide adhesive seam sealer certified in writing by the manufacturer as compatible with carpet backing. Seam sealer shall have minimum five year manufacturer's guarantee. Sealer shall create a 100% chemical weld at the seam site to provide a monolithic installation with a moisture barrier.
- C. Carpet Edge Guard: Shall be either aluminum or vinyl edge guard or transition in color suitable for a particular installation. Edge guard attachment shall be by mechanical fasteners or glued down.

- D. Tread Edge Strip: Shall be rubber or transition in color suitable for a particular installation.

### 3.0 EXECUTION

#### 3.1 INSTALLATION REQUIREMENTS

- A. All existing carpet and existing carpet waste shall be reused or recycled in an “environmentally friendly” manner. “Environmentally friendly” carpet recycling methods shall be performed subsequent to job completion. As used herein, “environmentally friendly” methods consist of the following:
  - 1. Repurposing – reusing the product in another application such as facilitating the donation of used carpeting to a charity or other nonprofit organization.
  - 2. Recycling – turning waste materials into new materials.
- B. Description of Reclamation Services – Carpet must be removed from the existing installation and prepared for pickup based on the type of material and reclamation option selected. Specifications for removal from the jobsite include:
  - 1. Removal of carpet tile and 6 foot roll carpet for repurposing or recycling
    - a. Carpet material shall be palletized and secured for shipping, (i.e., shrink wrap, banding, strapping).
    - b. Carpet shall be kept dry and free of any moisture damage.
    - c. Carpet shall be clean of any non-carpet debris.
    - d. Provide a certificate upon request verifying the reclamation of the carpet material.

#### 3.2 INSTALLATION CONDITIONS

- A. All sub floors shall be level, clean, dry, and free of dust, dirt, wax, paint, grease, cut back adhesive or any material that might interfere with the overall bond strength of the adhesive. Concrete floors shall be fully cured and free of excessive moisture and alkalinity. No condensation within 48 hours on underside of a four foot by four foot polyethylene sheet, fully taped at perimeter to substrate. Conduct moisture test maximum allowable amount of moisture emitted from floor shall be 3.0 pounds per 1,000 square feet in a 24 hour period.
- B. Store carpet and adhesive at a temperature of 70 degrees Fahrenheit for 48 hours prior to installation and maintain for 48 hours during and after completion.

- C. Do not expose adhesive to ultraviolet light. Adhesive may be photosensitive and lose its tack.
- D. For 6 foot roll carpet cut edges tight to form seams, without gaps, using carpet manufacturer's recommended seam sealer.
- E. When carpet is scheduled for installation on risers and treads, as in auditoriums, and the carpet project as specified with a vinyl cushion back will not install properly over risers and treads, the installer of the carpet project shall be required to provide and install rubber tread edge strips along the front edge of all treads including treads located within the seating areas.

Installer shall have at least five years of experience and be certified by the manufacturer of the carpet submitted.



## General Information

### Directories

Each building shall have at least one primary directory located in the main entrance of the building. Secondary directories on each floor may be required depending on the complexity of the building. Verify with User and Facilities Department.

### Graphics

Interior graphics shall be designed, shown and specified by the A/E and their placement in accordance with Texas Accessibility Standards. Use positive secure method to anchor graphics (tamper-proof screws or toggle bolts not double face tape or epoxy cement). Interior letters shall be Helvetica medium upper and lower case. Graphics for offices shall have area for changeable names.

All building utility spaces shall include the name of the space as well as room number on door graphics. Room numbering shall be approved by Facilities Department at Design Development approval.

Exterior graphics such as signs (except "Handicapped Parking" and traffic signs) and building letters will normally be furnished and installed by the Owner. During design the Project A/E will suggest locations on the building elevations for building name. Exterior letters are generally cast aluminum with mill finish or bronze satin duranodic finish, Helvetica medium font with both upper and lower case letters.

Traffic control signs shall be heat/vacuum baked process using 0.080 gauge aluminum blank sign face of Engineer grade reflectorized sheeting conforming to specification requirements of the Federal and State Manuals on Uniform Traffic Control Devices.

### Building Dedication Plaque

Bronze building dedication plaque shall be provided by contractor using approved wording.

### Toilet Partitions

Partitions or stalls should be floor mounted and constructed of solid plastic or stainless steel in all permanent buildings unless other materials are approved by the Owner. Provide coat hook and bumper guard on back of each toilet partition door. Coordinate the location of toilet partitions and floor drains.

## Corner Guards and Rails

Provide corner guards on corners of corridor walls with heavy pedestrian traffic.

Provide wall guard rails along corridor walls in laboratory areas to protect walls from lab carts.

## Toilet Accessories

Provide toilet accessories as required by each Campus

## Fire Extinguishers and Cabinets

Fire extinguishers and recessed or semi-recessed cabinets shall be incorporated into the design as required by code. Fire extinguisher cabinets shall be uniformly sized in building or campus.

Fire extinguishers selection and installation shall conform to the requirements of NFPA 10 *Standard for Portable Fire Extinguishers* or other codes as applicable. Fire Extinguisher shall be new extinguishers and be installed within one year of the manufacture date.

## Specific Campus Information

### Texas A&M University

### Rest Room Requirements

#### Paper Towel Dispensers

Georgia-Pacific Mfg# HDS200B Cormatic Series towel dispenser  
Georgia-Pacific Mfg# 59466 enMotion Touchless SS Towel Dispenser

#### Stainless Steel Paper Towel Receptacles

Georgia-Pacific Mfg# 59491 Stainless Steel Trash Receptacle  
American Specialties Incorporated Mfg#04692 with OM22 filler panel  
American Specialties Incorporated Mfg#04692-6 with OM22 filler panel  
American Specialties Incorporated Mfg#04692-9 with OM22 filler panel

#### Water Closet Tissue Dispenser

Georgia-Pacific Mfg# 56790 Compact Vertical Double Roll Coreless Dispenser  
Georgia-Pacific Mfg# 56784 Compact side-by-side Roll Bathroom Dispenser



## Soap Dispensers

GOJO Mfg# 2730-12 Black Touch Free Foaming Soap Dispenser

## Fire Extinguishers

Fire extinguishers selection and installation shall conform to the requirements of NFPA 10 *Standard for Portable Fire Extinguishers* or other codes as applicable. Fire Extinguisher shall be new extinguishers and be installed within one year of the manufacture date. Extinguishers shall be of the followings:

- 5#CO<sub>2</sub> Amerex Model #315 or equal
- 10#CO<sub>2</sub> Amerex Mode #330 or equal
- 10#ABC Amerex Model #419 or equal
- 20#ABC Amerex Model #423 or equal
- Class D Amerex Model #570 or equal
- Class K Amerex Model \$B260 or equal

## Tarleton State University

### Toilet Partitions

Comtec Industries (Scranton Products) Zero Sight Line Compartments

- One inch thick high-density polyethylene resins panels and pilasters
- Rounded radius edges on panels and pilasters
- Panels 55" high mounted 14" above finish floor
- Pilasters 82" high fastened into 3" high stainless steel or plastic pilaster shoe
- Heavy duty 8" aluminum hinges
- Heavy duty 6" aluminum door strike
- Heavy duty aluminum latch and housing
- Door with coat hook/bumper and pull
- Wall brackets 54" long aluminum or extruded plastic
- Headrail heavy duty aluminum
- Headrail brackets 20 gauge stainless steel

### Rest Room Requirements

|                   |   |
|-------------------|---|
| Towel dispensers: | Kimberly-Clark (Scott) 9719 or 9707           |
| Toilet Tissue     | Kimberly-Clark (Scott) 9796                   |
| Soap Dispenser    | Kimberly-Clark (Scott) 91101, 91102, or 91501 |
| Trash Receptacles | Kimberly-Clark (Scott) 9054                   |

## **Fire Extinguisher Cabinets**

Larson #2409-5R with Vertical Duo style door, clear acrylic door glazing, 1½” square trim semi-recessed trim protection and bronze anodized aluminum.

## **Texas A&M University-Corpus Christi**

### **Rest Room Requirements**

#### **Paper Towel Dispensers and Waste Receptacles**

James River - Series 2000  
James River - Max 2000

#### **Water Closet Tissue Dispenser**

James River - RollMaster

#### **Soap Dispensers**

James River - Carex Lotion Soaps

## **Texas A&M University-Kingsville**

### **Rest Room Requirements**

#### **Paper Towel Dispensers and Waste Receptacles**

Bobrick #B-39003 Dispenses C-fold, multifold and single fold.  
Surface mount, stainless steel

Bobrick #B-390039 Same as above but with stainless steel skirt for surface mounting

#### **Paper Towel Dispenser (Replacement)**

Continental Mfg.Co. #630C Stainless Steel, Singlefold only

#### **Water Closet Tissue Dispenser (Enclosed Box Type for Renovations)**

Bobrick #B-3888 Contura Multi-roll with plated steel dispensing mechanism for recessed areas

Bobrick #B-2888 Contura Multi-roll with plated steel dispensing mechanism for surface mount areas

### **Water Closet Tissue Dispenser (Replacement Single open roll type)**

Palmer Fixture Company #TP-202 Single Holder Hinged roller pin, security roller, non-controlled delivery, surface mount. Mount two single fixtures per stall

Bobrick #B-2730 Removable, security pin, non controlled delivery. Mount two single fixtures per stall

### **Water Closet Tissue Dispenser (Residence Halls)**

Royce Rolls Ringer Company Surface mount  
3 Roll #TP-3 Order Master Lock #TP-Lock or  
4 Roll #TP-4 Order Master Lock #TP-Lock

### **Soap Dispensers**

Plastic hand soap dispensers with mounting holes. The dispensers will receive prepackaged 800 ml liquid soap cartons and may take 1000 ml cartons

Johnson Soft Care Elite System  
DermaCare Hand Care

## **West Texas A&M University**

### **Rest Room Requirements**

#### **Paper Towel Dispensers and Receptacles**

Towel Disposal Units Georgia Pacific brand, model 59462 smoke color, which uses an 89460 towel.

#### **Water Closet Tissue Dispenser**

Bay West Model 722, Smoke Grey in color. Two-roll (2) vertical tissue locked enclosed cabinet

#### **Soap Dispenser**

DEB/SBS Pro line 1-litre White Dispenser, custom printed with the WT logo

### **Sanitary Napkin Disposal Unit**

Lagasse floor receptacle. White enamel finish, galvanized inner liners 9" W x 9" D x 11 ½" H. Serves two stalls with two spring-closing push doors on full length piano hinges.

### **Mop & Broom Rack (Located in janitor's closets)**

ASI Model 8215-4 20 gauge type 304 stainless steel satin finish 4" x 36" long with 4 rubber can holders ribbed for grasping.

### **Fire Extinguishers**

Kidde 5 lb., dry chemical extinguisher with hose. Canister meets DOT requirements and can be hydrostatic tested.

### **Texas A&M University-Commerce**

#### **Rest Room Requirements**

#### **Paper Towel Dispensers and Waste Receptacles**

Kimberly Clark Model 09994

#### **Water Closet Tissue Dispenser**

Kimberly Clark Model 09606

## Guide Specification

### Cast Bronze Dedicatory Building Plaques

#### PART 1 - GENERAL

##### 1.1 SECTION INCLUDES:

- 1.2 Description.
- 1.3 Submittals
- 1.4 Delivery, Storage and Handling
- 1.5 Job Conditions
- 2.1 Products

##### 1.2 DESCRIPTION:

- A. Work included: Furnish and install one (1) cast bronze plaque.

##### 1.3 SUBMITTALS:

- A. General Contractor will provide a request to the FPC project manager to initiate the plaque wording approval process.
- B. FPC will provide a final detailed layout drawing of the plaque to be used for procurement.

##### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver plaque crated to provide protection during transit and job storage.
- B. Inspect plaque upon delivery for damage and correctness.
- C. Store plaque where it is not exposed to the elements.

##### 1.5 JOB CONDITIONS

- A. Coordinate installation with work of other trades.

#### PART 2 - PRODUCTS

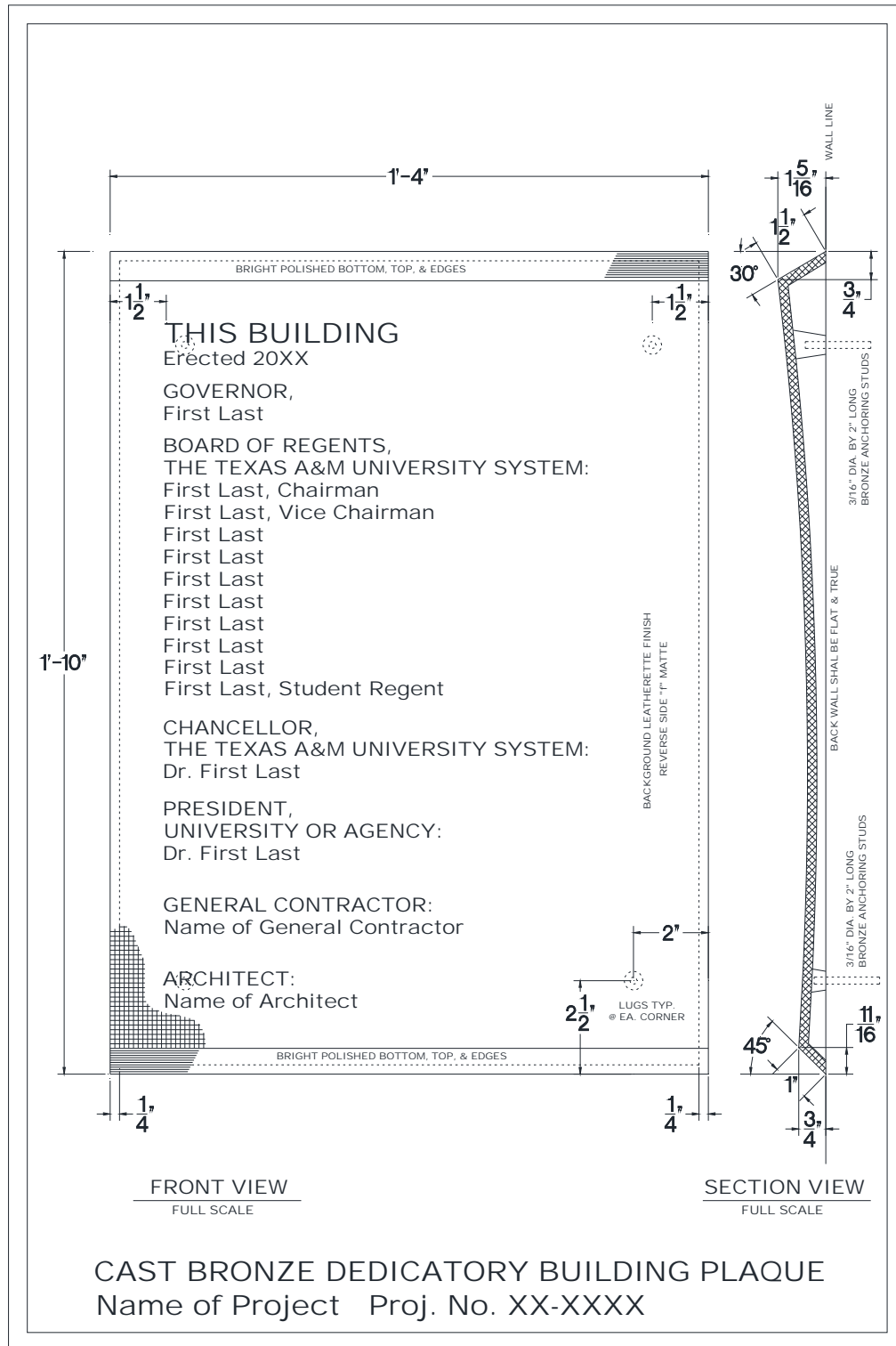
##### 2.1 CAST BRONZE PLAQUES

- A. Plaques shall be manufactured by Time Works Unlimited, Inc., P.O. Box 9052, College Station, Texas 77842-9052, (<http://timeworksunl.com/>), or approved equal. Tablet is to be cast of virgin ingots (85-5-5-5 standard U.S.

**Design Criteria**  
**Division 10 – Specialties**

Bronze Alloy). Casting shall be free of pits, porosity, imperfections and gas holes and all letters shall be sharp and hand tooled. The backs shall be flat and true. Border and faces of raised letters are to be a satin finish. Background shall be leatherette. Coat compound to ensure plaques will not bleed and discolor the mounting surface. Tap backs of plaques and provide bronze or stainless steel studs for blind fastening.

- B. Estimates may be obtained using the template provided.







## General Information

### Audio-Visual Equipment

Projection screens, where required by the Program of Requirements, shall be motorized and controlled by a **non-keyed** switch.

Audio visual equipment will may be purchased and installed under a separate contract. The design team must however identify this future equipment and provide a secure location to house it if requested by System Member.

In area where an assisted listening device is required or where sound reinforcement is required by the POR then a complete sound system shall be provided in the project.

### Laboratory Equipment

#### Laboratory Fume Hoods

The following are minimum design specifications for laboratory fume hoods and associated exhaust systems for A&M System projects except as modified with the approval of the System Member Director of Environmental Health and Safety.

1. All laboratory hoods shall meet the requirements of the National Fire Codes, NFPA 45, “Fire Protection for Laboratories Using Chemicals.” Hoods handling radioactive material shall also meet the requirements of NFPA 801, “Recommended Fire Protection Practice for Facilities Handling Radioactive Materials.” Fume hood systems shall also meet the requirements of the current ANSI Z9.5 Standard/ASHRAE 110 TEST. If the requirements below conflict with those of the most recent versions of these national standards, the national standards shall prevail.

Fume hood testing and certification shall be done by the fume hood manufacturer by an independent certifying firm and be done after the installation of the fume hood.

2. Hood design will incorporate airfoil jamb and airfoil sill to reduce airflow turbulence.

3. A variable volume or constant volume hood system design is preferred, depending upon the HVAC system design. For constant air volume hoods, bypass or balanced air feature should be considered to provide an inlet for air to

be drawn into the top of the hood as the sash is lowered, still maintaining the velocity through the face opening at 100 FPM. Hoods will be an integral part of the HVAC system.

4. Auxiliary Air Make-up Hoods with make-up air externally supplied above and on the outside of the hood face are not permitted.

5. Utility valves and switches shall be external, and shall be in conformance with applicable codes and standards. All service valves shall be easily accessible for maintenance personnel and clearly marked. Fixture outlets inside the hood shall be corrosion resistant or have a corrosion resistant finish.

6. Hood lighting shall be vapor or explosion proof, depending upon the intended purpose of the hood. Hood design should be such that light bulbs are changeable from the outside of the hood.

7. The hood sash shall be transparent, easily removable, horizontal sliding or vertical rising panel that will close off the hood face. All parts and counterbalance mechanism shall be of corrosion-resistant material and finish. The sash panel shall be safety glass or plastic that has a flammability rating of 25 or less.

Fume hoods with vertical sashes shall have stops at 18 inches. Whenever the sash is beyond 18 inches a visual alarm shall be activated.

8. Hood construction materials should be selected with regard to the requirements of hood use. Examples of material used include stainless steel and epoxy coated material.

9. Face Velocity Requirements:

Hood selection is greatly influenced by the type of experiments to be conducted within the hood. It is important to establish the maximum degree of hazard anticipated for present and future use before the choice of a hood is made. National standards recognize that the acceptable face velocity requirement for toxic materials used in research laboratories is an **average face velocity of 100 fpm** with the **hood sash fully open (100%)** and a **minimum at any point of 80 fpm**. These performance parameters are to be met. Fume hood testing shall be accordance with ANSI/ASHRAE 110.

10. Airflow Measuring Device:

An airflow measuring device shall be permanently installed on each fume hood. The device shall continuously monitor airflow face velocity, shall give a digital readout of face velocity, and shall sound an alarm for low-flow conditions or whenever the face velocity drops below 80fpm.

11. Exhaust Duct:

Fume hoods may be designed with either an independent exhaust duct system or a manifold system.

A high transport velocity of at least 2000 fpm is needed so that dust and aerosol-size materials are not deposited in the joints, cracks, or corners in the duct system. Normally all exhaust ducts will be constructed of Type 316L Stainless Steel, except where hydrofluoric acid or fluorides in general are used, with all TIG welded or mechanically fastened joints sealed with mineral impregnated woven fiber taper which is further impregnated with an activator/adhesive of the polyvinyl acetate type as manufactured by Hardcast, Inc. or equal. Ducts should be routed vertically with a minimum number of turns. Alternate duct materials will be considered in some applications.

Perchloric acid hoods shall have a completely welded exhaust duct system. Duct shall be routed by the shortest and straightest path to the roof. Horizontal runs are not permitted in Perchloric acid hoods. When required for construction, and approved by the Owner, flange joints and acid resistant gaskets may be used. Do not manifold perchloric hoods.

Perchloric acid hood exhaust outlets shall be flanged and furnished with a companion flange for welding to the exhaust duct.

12. Hood exhaust system design should provide for 10% minimum flow through exhaust duct when hood is not in service. The hood exhaust may be used as part or all of the required exhaust from the laboratory room.

13. Exhaust fans are to be located to the exterior of the building envelope and the pressure in the duct shall always be negative relative to the building.

14. Fume Hood Location:

No fume hood should be installed closer than 10 feet to the primary room entrance/exit door. Fume hoods should also not be installed near expected high

traffic areas within the laboratory or where supply air grills can cause turbulence at the hood face.

Suggested Fume Hood Manufacturers:

Kewaunee Scientific Equipment Corporation  
Statesville, North Carolina 28677  
704/873-7202

Hamilton Industries  
Two Rivers, Wisconsin 54241  
414/793-1121

Advanced Lab Concepts  
Houston, Texas 77284  
281/859-5496

15. Special Hoods:

Perchloric:

Perchloric acid hoods require a “wash down” feature in which water spray is used to remove acid crystals from the exhaust fan, ductwork, and hood plenum after each use. The water must not splash or fall on the work surface. Only one manual valve will control the wash down water. The valve handle shall be outside of the hood enclosure.

Each perchloric hood shall have an automatic five minute wash down cycle activated when the fume hood fan is de-energized.

Radioisotope:

Requires special construction to permit easy cleaning. Filtration requirements of the exhaust air and fume hood construction shall be determined on a case by case basis in consultation with the System Member Environmental Health and Safety Department’s Radiological Safety Officer.

Biological:

Biological Hoods shall meet NIH 03-112C Performance Specifications and shall be in accordance with National Sanitation Foundation Standard, NSF 49, and be listed by NSF. For application guidelines and filtration requirements use HHS Publication No. (CDC) 93-8395, “Biosafety in Microbiological and Biomedical Laboratories.”

Units shall be of steel or stainless steel construction; interior shall be stainless steel with coved corners. All seams and welds to be ground smooth and polished. Sliding view window shall be ¼" safety or tempered glass. Supply and exhaust HEPA filters shall be front loading and shall be 99.99% efficient for 0.3 micron sized particles. Unit shall be listed by UL and CSA for electrical safety. Unit shall include at least one petcock and one duplex outlet; additional services to be provided by user request. Unit shall include a fluorescent light and an ultraviolet (germicidal) light. Certification of unit after installation is required and must be performed by an approved certification company.

Suggested Biological Safety Cabinet Manufacturers:

NuAire Inc.  
BioMedical Solutions, Inc.  
281/240-5893

The Baker Company  
Scientific Resources Southwest, Inc.  
888/980-2845

Thermo Forma      800/848-3080

## Campus Specific Information

### Texas A&M University

#### Special Hoods

A list of approved certification companies is available from the Environmental Health and Safety Department.

#### Safety Showers

Floor drains are required beneath all safety showers.



## General Information

### Window Treatments

Window blinds and shades are considered to have a significant impact on the HVAC and Lighting systems in a building. Automatic and/or manual window blinds and shades shall be provided wherever practicable to support and enhance energy efficiency of building systems.

Horizontal 1” mini-blinds shall be included in the design for all spaces.

In spaces where more light control is required “Mecho Shades” or equal are acceptable.

### Laboratory Casework

Laboratory casework shall be high quality wood or steel construction unless other materials are appropriate due to space requirements.

Materials for laboratory tops shall be based on intended use.

Verify casework requirements and layouts for accessibility.

### Book Shelves

In order to maintain maximum room use and furniture placement flexibility typical faculty and staff offices shall not have built-in book shelving. Movable bookcases will be provided as Movable Furnishings where indicated in the POR.

### Furniture Selection

During the preparation of the POR, the FPC Interior Designer will consult with the User Coordinator to determine only the types and quantity of furniture needed to satisfy functional requirements.

The A/E in their Schematic and Design Development submittals will include furniture layouts to POR requirements to ensure accommodation in the space proposed for doors, columns, etc.

### Fixed Seating

All classrooms are to be designed to accommodate left-handed students. Ten percent of the total number of desks shall be for left handed people.

Seating shall be not less than 20 inches in width with preference for 22 inch width.

## Specific Campus Information

Tarleton State University

### Window Treatments

Levelor Cordless Mark I 1” blinds, lightmaster option.



## General Information

### Controlled Environment Rooms

Rooms defined as cold room, environmental rooms, plant growth chambers, etc. including controls shall be specified as complete units from a single manufacturer.

The design of refrigeration systems for environmental rooms and growth chambers shall be reviewed by the Mechanical Engineer only for coordination with the building mechanical systems.

Project A/E shall specify that the manufacturer of this equipment shall submit a detailed test procedure for factory testing the first unit of each type and that the Owner will witness the test.



## **General Information**

### **Elevators**

Elevators shall be selected and designed to comply with American Society of Mechanical Engineers/American National Standards Institute safety code for elevators, dumbwaiters and escalators, and moving walks, A17.1, latest revision as well as all requirements from with Texas Department of Licensing and Regulation and Texas Accessibility Standards.

Elevators manufactured by Otis, ThyssenKrupp, and Kone may be acceptable subject to meeting all applicable requirements of this section. Equal quality elevators of other manufacturers will be acceptable subject to approval of the Project A/E, the FPC Project Manager and the Member Facilities Department.

Elevator shall be specified to receive an electronic door safety device that extends the full height of the cab. Mechanical safety edge or traditional two beam photo-electric eyes are not acceptable.

Installation shall be by mechanic directly employed by the manufacturer or by installers franchised by and responsible to the manufacturer.

Electric operated elevators are preferred; however, oil hydraulic operation may be considered where use is intermittent or where elevator serves two floors.

General Contractor's use of elevators will only be allowed with written permission of the FPC Project Manager, Facilities Department and Elevator Vendor. Contractor shall be responsible for protecting interior finishes of all elevators. At Substantial Completion condition of all elevators shall be as new. Contractor's use of the elevator even with written permission of the Owner and vendor shall not relieve Elevator Vendor of any warranties expressed or implied. Provide complete inspection and maintenance service of each elevator for a period of 12 months at no cost to Owner. Elevator Vendor shall be able to show that they have had successful experience in the erection and maintenance of the type elevator equipment proposed for this project and that they maintain within 50 miles of the elevator installation an adequate stock of parts for emergency and replacement purposes; and that they have qualified men in their own employ available to insure the fulfillment of any maintenance and/or repair services without delay within one hour notification, 7 days a week on a 24 hour basis. Elevator Vendor must be firms established in operation for the past five years and having a proven selection of parts and service facilities to meet the qualifications stated above for 2 years. The elevator contractor must also be the manufacturer of the elevator being installed.

Provide BIM(s) of elevators to be used. Ensure that the following minimum data is associated with the model: manufacturer, model, number, speed, and capacity.

## **Passenger Elevators**

- Speed: 2 through 3 floors travel of 150 ft./min.;  
4 and above floors travel of 350 ft./min.;
- Capacity: Generally, stretcher number 3500 to 4500 pounds is specified depending on floor area and person density.
- Control: Selective/collective automatic for single cars. For multiple units of two or more, group automatic control. Solid state controls preferred.
- Diagnostic Tools: The elevator contractor shall provide to the Owner, integral with and built into the elevator controller, as part of this specification, any and all diagnostic tools and/or instruments and all written operating and instruction manuals needed to use the diagnostic tools required by the specification to allow for adjustment of any and all computer parameters and/or troubleshooting the equipment provided. These diagnostic tools shall be provided at no additional cost to the Owner. The Owner shall not be required to execute any type of written agreement in order to obtain said tools. The use of any handheld or removable diagnostic devices shall be specifically prohibited. The integral diagnostic tools and/or instruments shall permit the Owner and/or his authorized representative to access, diagnose and/or adjust any and all computer and/or software based variable features and/or parameters for the entire lifespan of the new equipment provided as required by the specification.
- Operation: Leveling with resistance operation through 150 ft./min.; generator or solid state control for 200 ft./min. and above.
- Cab: Stainless steel front and car door, stainless steel base, plastic laminated sides and rear, luminous ceiling with UL approved, manufacturer's Standard concealed fluorescent lighting, exhaust fan, stainless steel handrails on three sides and contain a device for voice communication to meet Texas Accessibility Standards.

The cab should have the following as standard features:

- A. Emergency Phone
  - 1. Hands free, auto dial, flush mount, vandal resistant
- B. Door Operators

**Design Criteria**  
**Division 14 – Conveying Equipment**

- 1. Heavy duty
  - C. Door Protection/Reopening Device
    - 1. Infrared electronic scanning
  - D. Fireman service key switches phases I and II
    - 1. “Adams” cylinders with WD01 key
  - E. Cab Lights
    - 1. Fluorescent or screw-in base with easy access for replacement
  - F. Vandal-resistant car enclosures
    - 1. Swing return (hinged) car stations
    - 2. Hall and car button and fixtures
- Hoistway Entrances: 3'-6" min. width, 7'-0" high, baked enamel finish, power operation.
- Machine Location:
- Electric elevators: Overhead preferred, but location at lower level optional on installations of four floors and less.
- Oil hydraulic elevators: Not above first floor, adjacent to hoistway preferred.
- Platform: Size according to code for capacity; however, standard sizes should be selected.
- Signals: Provide Braille markings on car operating face plate and call signals and other features. One emergency alarm bell button in each car connected to emergency alarm station at main floor. Position indicators, direction arrows, and hall, and car buttons should be L.C.R. or L.E.D. standard 100,000 hour lamps
- Flooring: Same as adjacent area by flooring subcontractor.
- Floor Lockout Provisions: Provisions shall be included if directed by FPC Project Manager.

## Design Criteria Division 14 – Conveying Equipment

- Emergency Generator:** Interlock with emergency generator if Emergency Power System is approved for building. Otherwise, make no provision for emergency generator for elevator unless specifically directed to do so by the FPC Project Manager and Facilities Department.
- Hooks & Pads:** Hooks shall be installed in all passenger elevators. In addition, one complete set of pads shall be furnished for the Contractors' and Owners' use during construction. Prior to final acceptance, the pads are to be furnished in good condition and clean to the Owner.

### **Combination Passenger/Service Elevators**

Will be designed to meet requirements of passenger elevators; cab size, hoistway entrances and capacity to meet freight requirements.

### **Freight Elevators (Freight only)**

- Speed:** Up to and including 2 floors travel of 50 ft./min.; above 2 floors travel 100 ft./min.
- Capacity:** Minimum of 2500 pounds; however, product and product weight should be considered.
- Control:** Same as for passenger elevator operation except for 2 floor installation single automatic pushbutton.
- Operation:** Same as passenger service.
- Cab:** Standard freight (steel wainscoting).
- Hoistway entrances:** Bi-parting type. Generally, door operation is manual; however, consideration should be given to power operation where use of equipment is extensive.
- Signals:** Door open bell, in use light and illuminating buttons.
- Machine Locations:** Same as passenger elevators.
- Platform:** Size and classification according to code, building requirements, and capacity.

## Campus Specific Information

### Texas A&M University

### Elevator Requirements

Electric operated elevators are required. Oil hydraulic elevators are not acceptable.

Electric elevators: Overhead preferred, but location at lower level optional on installations of four floors and less. Machine-room-less-elevators as manufactured by Kone are acceptable. For machine-room-less elevators, provide a 24" x 24" fire-rated access door near the top of the shaft to access the governor and the brake. This access door shall be located such that the frame of the elevator does not impede access to the governor or the brake. Coordinate location height of access door with manufacturer.

#### 1. Pit

- A. Sumps in pits shall be covered. The cover shall be level with the pit floor.
- B. Interior and exterior of elevator pits shall be water-proofed
  - 1. Means to prevent the accumulation of water shall be provided.
  - 2. Removal of water from pit per ASME A17.1.
  - 3. Sump holes, if used, must be covered with a metal grate flush with the pit's floor.
- C. Provide, at minimum, the following electrical devices in the elevator pit adjacent to each pit ladder.
  - 1. Weather proof light fixture.
  - 2. Weather proof light switch for light fixture.
  - 3. Weather proof duplex 120V GFCI power outlet.

#### 2. Machine Rooms

- A. A self-closing, self-locking, properly rated machine room door is required.
- B. The elevator machine room shall be properly ventilated, heated and cooled.

## Design Criteria Division 14 – Conveying Equipment

- C. Provide a 120-volt, 20 amp, circuit for car lights, fan and alarm circuit. This circuit must be provided with a lockable disconnect per NEC 620-53.
  - D. Provide adequate 120-volt receptacles in each elevator equipment room. Each outlet shall be GFCI.
  - E. All disconnects located in the elevator equipment room shall be able to be secured with a lock.
  - F. If battery lowering is specified provide an auxiliary contact on the main disconnect for the elevator equipment. This contact shall be used to determine the difference between a power outage and a maintenance or emergency shut down.
  - G. Provide a 10-pound ABC fire extinguisher in each machine room.
  - H. Only such equipment directly required in the function or support of the elevator system is allowed in the machine room or hoist way. No other equipment, piping drains, etc., is permitted in this space.
3. Fire Protection and Alarm Detection
- A. Smoke detectors must be installed in each elevator equipment room and elevator lobby. They must be so arranged that if activated, the elevators will go into recall mode. Activation of the smoke detector will recall all elevators to the designated floor.
  - B. If the building is fully sprinkled, then the following requirements must be met:
    - 1. Sprinklers shall be installed in hoist ways and elevator equipment rooms in accordance with **NFPA 13.8.14.5** (not more than 2 feet above the floor of the pit for hydraulic elevators).
    - 2. A heat detector must be installed within 6 inches of each sprinkler head located in the hoist ways or elevator equipment rooms. The fire alarm system must function such that when the heat detector's temperature rating is reached, the fire alarm system shunt trips the main breaker in the elevator equipment room in accordance with **ASME A17.1 Rule 102.2 C (3) and (4)**. **A smoke detector shall be installed.**



**Design Criteria**  
**Division 14 – Conveying Equipment**

3. Temperature settings for heat detectors and sprinkler heads shall be as follows:
    - a. Heat detectors: 175 to 195 degrees.
    - b. Sprinkler heads: 200 to 225 degrees (The sprinkler head rating will be picked so as to be approximately 25 degrees higher than the temperature rating of the heat detector.)
  4. If elevators are powered from emergency power. Interlock wiring (conduit and wire) must be provided between the transfer switch and each elevator equipment room and between each elevator equipment room.
  5. The battery lowering option cannot be provided if the emergency power option is purchased.
  6. One analog telephone line per elevator shall be installed in each elevator room.
4. Elevator Cab
- A. Provide an ADA approved flush mounted telecommunications device in each elevator. Use of this device shall not require the opening of a door.
  - D. Elevator Car Interior to Controller Communication Requirements
    4. In addition to the emergency phones required to be provided in elevators, separate means shall be provided to enable two-way voice communication between the controller location and the interior of each individual car, complying with the following:
      - i. Each two-way communication device must have emergency power back-up for at least 4 hours.
      - ii. Each two-way communication device shall not be a part of the existing emergency phones. They shall be installed separately from communication devices already present.
      - iii. They shall not require intervention by a person inside the car to establish two-way communication or allow communication to be disconnected from inside the car. All manual operation of the device shall be done by emergency personnel from the controller location and no

## Design Criteria Division 14 – Conveying Equipment

operation shall be required of persons inside the elevator car.

- iv. Once two-way communication has been established a visual indication within the car shall illuminate and only extinguish when the communication link is terminated by emergency personnel.
- v. Operating instructions (AMSE A17.1-2.27.7.3) shall be provided adjacent to the two-way communication device in the controller location.

### 5. Quality Assurance

- A. No variance to the codes shall be sought from the governing authority without written approval from the Facilities Services Elevator Representative.
  - 1. Copies of variances, if granted, shall be submitted to the Facilities Services Elevator Representative for record.

### 6. Submittals

- A. Product Data: including capacities, speed, size, and type.
  - 1. Provide this data at the design stage of the project to verify that the elevator will meet the anticipated traffic and handling demands of the building's design before proceeding to the development phase of the project.
- B. Provide three (3) copies of both full line and schematic diagrams including nomenclature definitions and symbol keys for the entire elevator system.
  - 1. Provide three (3) copies of operating and maintenance manuals, parts lists, diagnostic documentation, sequence operation, and manufacturers' parts numbers. For the entire elevator system, wire pull sheets shall be left on the job for future trouble shooting and shall become the property of the University.
  - 2. Provide three (3) sets of all keys for all keyed features of the elevator system.
  - 3. Provide any diagnostic tool necessary for maintenance, adjusting, testing, inspecting, and troubleshooting any part of the elevator system.

**Design Criteria**  
**Division 14 – Conveying Equipment**

7. Demonstration and Training
  - A. On-site training shall be provided by the original equipment manufacturer for enrollment by individuals selected by the Facilities Services Superintendent for Operations Maintenance to learn about installation, adjustment maintenance and troubleshooting the equipment. Any fees or costs of training for up to six (6) persons shall be included in bid price. Fees for additional persons shall be stated in bid and shall be at a reasonable cost.
  
8. Warranty
  - A. Written warranty, signed by manufacturer, agreeing to repair, restore, or replace defective elevator work within specified warranty period.
    1. Warranty period of 12 months
  
9. Final Acceptance Test
  - A. All tests required by the authority having jurisdiction (Texas Department of Licensing and Regulation) shall be witnessed by the Facilities Services Qualified Elevator Inspector and shall use the Facilities Services Elevator Equipment Inspection form. This form shall be signed by the Facilities Services Area Maintenance 7 Representative. All inspection reports shall be delivered to Facilities Services Area Maintenance 7.

**Design Criteria**  
**Division 14 – Conveying Equipment**

## General Information

The A/E shall identify on the drawings all areas that may be classified as hazardous in accordance with the latest edition of the NFPA Codes or that may pose a health hazard due to noise levels, radiation, chemical fumes, etc. The A/E shall describe how each such area will be treated in the building design.

All CM/GC is responsible for modeling all of the fire suppression system using BIM authoring software.

## Fire Suppression Systems

### **Sprinkler and Standpipe, Hose Systems:**

Design and installation of sprinkler systems shall meet FM 2-0 and FM 3-26: *Fire Protection Water Demand for Nonstorage Sprinklered Properties* unless fire hazards are specifically addressed by other FM Data Sheets (e.g. Co-Generation Plants). Fire protection drawings, calculations and listing of all equipment to be installed should be submitted to FM Global Plan Review Services for review prior to installation. Submittals should be in accordance with the FM *Global Plan Review Procedures Document*

General fire protection spacing requirements in Hazard 1, Non-storage occupancies (such as classrooms, lecture halls, etc.) as outlined in the table below:

*FM Data Sheet 2-0: Installation Guidelines for Automatic Sprinklers*

Table 3. Spacing of Ceiling-Level Pendant and Upright Nonstorage Sprinklers for Hazard Category No. 1

| Ceiling Height, ft (m) | Ceiling Type  | K-Factor  | Orientation        | Response          | Linear Spacing, ft (m) |          | Area Spacing, ft <sup>2</sup> (m <sup>2</sup> ) |            |
|------------------------|---|---|--------------------|-------------------|------------------------|----------|---|------------|
|                        |   |   |                    |                   | Min.                   | Max.     | Min.  | Max.       |
| Up to 35 (10.5)        | Noncombustible Unobstructed, Noncombustible Obstructed, or Combustible Unobstructed | 5.6 (80), 8.0 (115), or 11.2 (160),                             | Pendant or Upright | Quick or Standard | 7 (2.1)                | 15 (4.5) | 70 (6.5)  | 225 (21.0) |
|                        |   | 14.0 (200), 16.8 (240), 19.6 (280), 22.4 (320) or 25.2 (360)    | Pendant or Upright | Quick             | 7 (2.1)                | 15 (4.5) | 64 (6.0)  | 225 (21.0) |
|                        |   |   | Pendant            | Standard          | 7 (2.1)                | 15 (4.5) | 64 (6.0)  | 225 (21.0) |
|                        |   |   | Upright            | Standard          | 7 (2.1)                | 15 (4.5) | 70 (6.5)  | 225 (21.0) |
|                        |   | *5.6EC (80EC), 8.0EC (115EC), 11.2EC (160EC), or 14.0EC (200EC) | Pendant or Upright | Quick             | 10 (3.0)               | 20 (6.0) | 100 (9.0)                                       | 400 (36.0) |
|                        |   | *25.2EC (360EC)   | Pendant or Upright | Quick             | 10 (3.0)               | 14 (4.2) | 100 (9.0)                                       | 196 (18.0) |
|                        | Combustible Obstructed  | 5.6 (80), 8.0 (115), 11.2 (160)                                 | Pendant or Upright | Quick or Standard | 7 (2.1)                | 15 (4.5) | 70 (6.5)  | 169 (15.5) |
|                        |   | 14.0 (200), 16.8 (240), 19.6 (280), 22.4 (320) or 25.2 (360)    | Pendant or Upright | Quick             | 7 (2.1)                | 15 (4.5) | 64 (6.0)  | 169 (15.5) |
|                        |   |   | Pendant            | Standard          | 7 (2.1)                | 15 (4.5) | 64 (6.0)  | 169 (15.5) |
|                        |   |   | Upright            | Standard          | 7 (2.1)                | 15 (4.5) | 70 (6.5)  | 169 (15.5) |
|                        |   | *5.6EC (80EC), 8.0EC (115EC), 11.2EC (160EC), or 14.0EC (200EC) | Pendant or Upright | Quick             | 10 (3.0)               | 20 (6.0) | 100 (9.0)                                       | 400 (36.0) |
|                        |   | *25.2EC (360EC)   | Pendant or Upright | Quick             | 10 (3.0)               | 14 (4.2) | 100 (9.0)                                       | 196 (18.0) |
| Over 35 (10.5)         | Noncombustible Unobstructed   | 11.2 (160)  | Pendant or Upright | Quick or Standard | 8 (2.4)                | 12 (3.6) | 80 (7.5)  | 120 (11.0) |
|                        |   | 14.0 (200), 16.8 (240), 19.6 (280), 22.4 (320), or 25.2 (360)   | Pendant or Upright | Quick             | 8 (2.4)                | 12 (3.6) | 64 (6.0)  | 120 (11.0) |
|                        |   |   | Pendant or Upright | Standard          | 8 (2.4)                | 12 (3.6) | 80 (7.5)  | 120 (11.0) |
|                        |   | *25.2EC (360EC)   | Upright or Pendant | Quick             | 10 (3.0)               | 14 (4.2) | 100 (9.0)                                       | 196 (18.0) |

\*Applies where extended coverage sprinklers are acceptable in the presence of obstructed type construction. Such construction may require the sprinklers be installed in every channel formed by the obstructed ceiling construction.

All piping to be Schedule 80 A-53.

The A/E shall be responsible for modeling, using BIM authoring software, and including in the Construction Documents the Fire Protection Sprinkler System—Sprinkler Head and main header location, plans, riser locations and diagrams. Risers shall include

sprinkler header take-offs with Fire Alarm points located. Drawing shall be laid out to allow for the addition at completion of construction as all as built header and branch piping to each sprinkler head. The Fire Protection Sprinkler and Standpipe System shall be designed by a Registered Professional Engineer or an organization which possesses a valid Certificate of Registration as issued by the State Fire Marshal and has at least one (1) person engaged in or working on the actual plans, who is licensed to perform the work authorized by its certificate.

Electrical equipment rooms are not required to be sprinkled when the room and equipment conforms to the requirements of NFPA 13.

All materials shall be FM Global approved products and data sheets are available at [www.fmglobal.com](http://www.fmglobal.com). Compliance with Article 5.43.3 of the Texas Insurance Code and NFPA 13 is required. Test drains need to be located at the end of each run with a two inch drain located at the main and piped to a drain or outside.

Hoses need not be installed unless specifically required by other NFPA Chapters.

Grooved pipe is acceptable for fire protection systems.

Provide insulation and heat tracing for fire protection piping in crawl spaces and ceiling spaces at exterior areas such as loading docks, drive thrus, or canopies.

Specify galvanized or cad plated rods and hangers for sprinkler piping. Do not allow black iron rods or shot anchors for hanging sprinkler piping.

Provide a cleaning specification for sprinkler piping.

All sprinkler piping shall be schedule 40 pipe and **fully** reamed.

**Mechanical/HVAC Equipment Rooms:** If the equipment room does not contain oil-filled electrical equipment or other flammable liquids, Fire protection should be designed for 0.15 gpm/sq.ft. over a remote area of 2,500 sq.ft., with a 500gpm hose allowance.

**Electrical Rooms/Switchgear Rooms:** Are **not** required to have fire protection systems if:

- The electrical rooms are provided with a 2-hr fire rated enclosure
- FM Approved Monitored Heat/Smoke Detection is provided
- All wall penetrations are properly sealed with fire-rated material
- The area is kept free of combustibles, and housekeeping polices must be in effect
- No oil-filled transformers or switchgear are present

If oil-filled/oil-insulated switchgear or transformer equipment is present, fire protection should be designed for 0.20gpm/sq.ft. over a remote area of 3,000 sq.ft. with a 500gpm hose allowance

*Excerpt from DS3-26 Table 2. Minimum Protection Criteria for Non-manufacturing and Non-Storage Areas with High Floor-to-Ceiling Clearance*

| Occupancy Description   | Water Demand<br>(gpm/ft <sup>2</sup> )/ft <sup>2</sup><br>(mm/min)/m <sup>2</sup> |                      | Exception:<br>Occupancy Description  | Water Demand<br>(gpm/ft <sup>2</sup> )/ft <sup>2</sup><br>(mm/min)/m <sup>2</sup> |                          |
|---|---|----------------------|--|---|--------------------------|
|   | Wet System  | Dry System           |  | Wet System  | Dry System               |
| I. Power houses, utility and equipment rooms. Occupancies relating to utilities, such as heat, light and power generation or transmission, refrigeration or compressor rooms, except as noted. Examples: Engine rooms, power and switch gear rooms, air conditioning equipment rooms. | 0.20/3000<br>(8/280)  | 0.20/4000<br>(8/370) | 1. Operations involving hydraulic fluids   | DS 7-98   | DS 7-98                  |
|   |   |                      | 2. No oil-filled electrical equipment or other flammable liquids or gases such as oil lubrication or cooling systems | 0.15/2500<br>(6/230)  | 0.15/3500<br>(6/330)     |
|   |   |                      | 3. Telephone switchgear rooms  | DS 5-12,<br>5-14 or 5-23  | DS 5-12,<br>5-14 or 5-23 |
|   |   |                      | 4. Generator rooms   | DS 5-12   | DS 5-12                  |
| Hose stream demand: 500 gpm (1900 L/min). Duration: 60 min  |   |                      |  |   |                          |
| L. Occupancies not involving storage or manufacturing. Examples: Apartments, offices, drafting, hospitals, institutions, hotel rooms, kitchens, libraries, photographic processing areas, restaurants, schools  | 0.10/1500<br>(4/140)  | 0.10/1500<br>(4/140) | 1. Libraries with large stack rooms  | DS 2-8  | DS 2-8                   |
|   |   |                      | 2. Storage of electronic media   | DS 8-9  | DS 8-9                   |
| Hose stream demand: 250 gpm (950 L/min). Duration: 60 min   |   |                      |  |   |                          |

**Data Centers:** Wet sprinkler systems or FM Approved preaction systems are recommended, and should include FM Approved smoke actuated fire detection or air-sampling type detectors, automatic emergency shutdown (*manual EPO can be installed for small or non-critical data centers*), and meet the design criteria outlined in FM Data Sheet 5-32. A sprinkler density of 0.15gpm/ft<sup>2</sup> over 2000sq. ft. should be provided. Where the area is well subdivided, the area of demand should be 2,000sq.ft, or the largest compartmented area whichever is smaller. An FM Approved Water Mist System is acceptable if all criteria outlined in FM Data Sheet 5-32 are satisfied. Hose stream demand in all cases is 250gpm. Sprinklers should be rated for 165F temperature rating. Quick response sprinklers should only be used on wet sprinkler systems. (*See Below for Special Protection Systems*)

**Emergency Generator Rooms:** Provide automatic sprinkler protection in the generator room designed to deliver a density of 0.25 gpm/ft<sup>2</sup> (10 mm/min) over 4000 ft<sup>2</sup> (372 m<sup>2</sup>) (286F sprinklers) plus 500 gpm (1900 l/m) for hose streams.

### Special Systems

All special protection systems should be installed in accordance with FM 4-0: *Special Protection Systems*, and FM 4-9: *Clean Agent Fire Extinguishing Systems*. These systems should not be installed in any area where moderate to heavy loading of ordinary combustibles will be present (i.e. special collections in libraries, storage areas for Data Centers, etc.)



If special protection systems are to be used in Data Centers, they must be designed in accordance to FM Data Sheet 5-23, specifically 2.4.2.1.1 *Gaseous extinguishing*, and FM Data Sheet 4-0, Data Sheets 4-2 and Data Sheet 4-9.

Systems designed to protect equipment or special hazard areas shall be an automatic total flooding FM-200 extinguishing system, with fire detection designed to conform to the requirements of the National Fire Protection Association codes and standards (NFPA 2001, NFPA 72, and other applicable codes).

The system shall be designed and installed by an experienced firm regularly engaged with automatic flooding FM-200 fire extinguishing systems. The firm shall have a minimum of five (5) years experience in design, installation, and testing of these systems and shall be certified and licensed by the State Fire Marshal's Office in accordance with Article 5.43.1 of the Texas Insurance Code.

It there is an FM-200 system the contractor must perform two (2) tests.

## **Campus Specific Information**

### **Texas A&M University**

#### **Fire Department Lock Box**

Key Boxes shall be installed on all new buildings or buildings being renovated that do not currently have a key box. The key box shall be located at or near the primary fire department access at eight feet (8') above the finish elevation. The approved College Station Fire Department key box shall be a "Knox Box."

The tamper switch shall be connected directly to the Siemens "Apogee" fire alarm system.

#### **Fire Department Connection**

Fire Department connections shall have Knox FDC Cap Model No. 3010 stainless steel with key wrench.

#### **Fire Suppression Systems**

Stand pipes and mechanically operated water gongs are required in all buildings having two or more floors. Installation shall conform to the latest version of NFPA 14.

Sprinkler systems with mechanically operated water gongs are required in all buildings. Installation shall conform to the latest version of NFPA 13.

Distance from the fire hydrant to any portion of a new or renovated building shall be less than 300 feet. Distance from fire hydrant to fire department connection shall be less than 100 feet.

EHSD must approve the following:

- a. the type, number and location of fire extinguishers,
- b. alternative fire suppression systems, and
- c. emergency power generator fuel tanks in excess of 1000 gallons

## **West Texas A&M University**

### **Fire Protection Piping:**

2-1/2 inches and larger:

Piping: ASTM A135 UL listed, threadable, light wall; Schedule 10 black

Mechanical Grooved Fittings: UL Listed and FM Approved, ASTM A536 ductile iron or ASTM A958 cast steel,

Mechanical Grooved Couplings: ASTM A-536 Ductile or Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers.

2 inches and smaller:

Piping: ASTM A135 UL listed, threadable; Schedule 40 black

Fittings: Cast iron or ductile iron, ASTM A126 Class B, ASME B16.4 class 125.

## **General Information**

Provide necessary services, piping, connections, fittings, and fixtures for floor drains, drinking fountains, custodial floor sinks, work room sinks, student laboratories, and toilets as required in the Requested Facilities. Provide a single hose bib with lock shield under the lavatories in each restroom. Provide the capability for a fume hood and shower and dressing capabilities in the Wet Lab area. Use the latest International Plumbing Code for requirements. Submit plumbing calculations with the Design Development submittal. Any changes to the plumbing design and calculations shall be submitted a minimum of one week prior to the first interim Construction Documents review meeting.

Room numbers must appear on plumbing plans and room names where space is available. Column lines or designations shall appear on all plumbing sheets as they appear on architectural and structural sheets.

Plumbing and HVAC systems shall be drawn as separate sheets. These systems may be combined only by written permission of the FPC Project Manager.

CM/GC shall provide as-built BIM(s) of all plumbing piping and valves 2” and larger as well as any plumbing equipment.

Where piping systems are to be installed underfloor, these shall be shown on an underfloor plan and not on the plan prepared for the space above. Floor plans for mechanical systems shall be drawn to show pipes, ducts, etc. on the floor in which they are installed. In general, underfloor plans shall be drawn to show all piping underfloor and, from there up, the systems between each floor slab shall be shown only on the appropriate floor plan.

All construction details shall be shown on the drawings and shall not be bound in the specifications.

All equipment and material specifications shall be bound in the specifications and shall not be shown on the drawings.

Performance data for all plumbing equipment shall be shown in schedules on the drawings. This data may also be included in the specifications but shall be carefully edited for conflicts.

The A/E shall identify on the drawings all areas that may be classified as hazardous in accordance with the latest edition of the NFPA CODE or that may pose a health hazard due to noise levels, radiation, chemical fumes, etc. The A/E shall describe how each such area will be treated in the building design.

Provide frost proof hose bibs and weather proof duplex electrical outlets on exterior of

buildings. Major buildings should have minimum of one hose bib and one electric outlet on each face of building.

Coordinate with the structural for block outs at floor drains.

1. All domestic water to be protected by a reduced pressure backflow preventer.
2. All domestic water interior to the building shall be type L copper with soft solder joining. All underground shall be type K. No joints in inaccessible areas under slabs unless silver soldered.
3. Underground sanitary to be hub and spigot and cast iron. Interior of the building shall be no hub C.I.
4. All underground on campuses located at the coast shall have P.V.C. sanitary systems.
5. All ball valves shall be two piece full port with threaded ends stainless steel ball and stem.
6. All butterfly valves shall be drilled and tapped lugged body or full flanged.
7. All systems shall be sterilized to meet health department requirements.
8. All underground domestic water shall be ductile iron, P.V.C. or copper.
9. All underground gas piping shall be polyethylene with fusion welded anodeless riser turn up,
10. All lab gases shall be installed with type L copper and fuel gas to be installed with schedule 40 black steel pipe interior to the building.

## **Metering**

All buildings shall be designed for metering of campus water. All auxiliary areas in a building shall be sub-metered.

## **Piping**

Gas lines shall be of all welded black steel construction inside of the building to emergency shut-off valves. Gas lines from valve to lab table or appliances may be screwed black steel with M.I. fittings for 3/4" and smaller. All building gas piping shall be designed and installed in accordance with National Fuel Gas Code, NFPA 54, latest edition.

All control valves shall be listed in a schedule on the drawing showing identification

number, body size, port size, if applicable, whether normally open or closed, spring range, and CV.

Provide insulation on all roof drain lines and overflow lines and pipes that accept condensate.

All interior water piping shall be type L copper with soft solder joints. For exterior applications where copper tube is specified, it shall be Type K.

Underground sanitary sewer to be cast iron, hub and spigot. No hub cast iron may be used in the interior of the building

Riser diagrams to show all waste, vent, supply piping, and cleanouts.

Provide threaded wall stops at all lavatory and sink water supply piping.

Deionized water piping shall be completely drainable. All low points and traps in the system shall have the capability to drain the system completely prior to starting the system.

Victaulic type couplings may be used for piping in equipment rooms only. Victaulic piping systems may be used on fire protection systems for piping 2-1/2 inches and larger only.

## **Plumbing**

Buildings shall be designed to permit gravity flow of sanitary and storm drainage (12 inch maximum storm drain size). Where sewage ejectors or sump pumps are required, they shall be located to have sufficient headroom to pull the pump shaft straight up through the floor plate. Lifting eyes or trolley beams shall be provided to facilitate the removal of the equipment. Emergency power shall be provided if failure of pump would damage or flood electrical or mechanical equipment. A high level alarm shall also be provided.

Pipes penetrating exterior walls below grade must be installed properly to prevent breakage due to building settlement or expansive soil.

All connections to campus distribution systems or public utilities shall be precisely located by dimension or coordinates. Depth of piping shall be shown and inverts will be shown at manholes and other critical points.

Access shall be provided to all working parts of plumbing devices. Do not permanently seal in wall any plumbing items requiring periodic operation or maintenance.

Cleanouts shall be located at each bend and every 50 feet in straight runs.

Roof drains shall be run separately from all other storm water sources to outside of the building. All overflow drains shall be piped independently of the roof drain system

Roof overflow drains shall be designed in compliance with the International Plumbing Code. Scuppers can be used instead of overflow drains.

Caulk all toilets, urinals, and lavatories at the wall interface.

All toilet bowls and urinals to be set within 1/16" of the finished wall.

Provide 1-1/2" P-trap for all lavatories and provide ADA protection where required.

Provide Shokstops on all water piping in toilet battery chases with valve upstream of stop for maintenance. Install either above the ceiling or behind an access door for maintenance at the end of the header.

All no-hub cast iron to be provided with hangers within 18" of the hub on each side.

Provide drum sediment traps for all fume hoods and lab sink drains.

For domestic water supplied to a building, a reduced pressure double check valve assembly is required. For fire protection water supply, a simple double check valve assembly is required.

## **Mechanical Equipment Room**

Provide at least one (1) 4" floor drain with trap seal protection in each equipment room. Locate out of walking area, but not under equipment. Connect to sanitary sewer system. Locate one (1) domestic water line hose bib with vacuum breaker in each equipment room for coil washing.

## **Rest Rooms**

Each rest room should have at least one 4" floor drain when serving 80 or more square ft. and 3" min. for less area. (Locate under stall partition or where one is not likely to walk). Floor drains shall be provided with automatic trap seal protection. Each rest room shall have supply of conditioned air and a positive exhaust air system.

Coordinate the location of toilet partitions and floor drains. The drain shall be under the partition but not adjacent to the support.

For sanitary cleanouts in or near restrooms, place the cleanout(s) at a higher elevation than the flood rim of the surrounding fixtures.

Each restroom shall have at least one hose bib with a vacuum breaker provided.

Provide stainless steel access doors for restrooms.

## Specific Campus Requirements

### Texas A&M University

#### Metering

Domestic Cold Water – the meter shall be exactly like the type manufactured by Rosemount under the product umbrella “Rosemount 8705 magnetic flow meter”. All meters should be equipped with a Rosemount remote transmitter model 8712. Meter should be installed per the manufactures specifications and should be field verified by physical plant – utilities personnel. Approval from the Office of Energy Management must be obtained before sizing the flow meter to ensure it is within allowable flow ranges. Flow wiring from the transmitter will be run to the WAGES PLC.

Domestic Hot Water – The meter shall be exactly like the type manufactured by Rosemount under the product umbrella “Rosemount 8705 Magnetic Flow Meter”. All meters should be equipped with a Rosemount remote transmitter model 8712. Meter should be installed per the manufactures specifications and should be field verified by Physical Plant – Utilities personnel. Approval from the Office of Energy Management must be obtained before sizing the flow meter to ensure it is within allowable flow ranges. Flow wiring from the transmitter will be run to the WAGES PLC.

Irrigation Water – The meter shall be exactly like the type manufactured by Rosemount under the product umbrella “Rosemount 8705 Magnetic Flow Meter”. All meters should be equipped with a Rosemount remote transmitter model 8712. Meter should be installed per the manufactures specifications and should be field verified by Physical Plant – Utilities personnel. Approval from the Office of Energy Management must be obtained before sizing the flow meter to ensure it is within allowable flow ranges. Flow wiring from the transmitter will be run to the WAGES PLC.

### Tarleton State University

#### Plumbing Fixtures

|                 |                                     |
|-----------------|-------------------------------------|
| Water Closet    | Kohler Kingston K-4330 (wall mount) |
| HC Water Closet | Kohler Kingston K-4300 (wall mount) |
| WC Flush Valve  | Sloan Royal #111                    |
| Urinal          | Kohler Bardon Superior K-4960-ET    |
| HC Urinal       | Kohler Bardon Superior K-4960-ET    |

Urinal Flush Valve            Sloan Regal #186

NOTE: All water closets and Lavatories shall be on Carriers

Lavatory                            Kohler Chesapeake K-1729 (wall mount)

HC Lavatory                      Kohler Morningside K-12634

Lavatory Faucet                Kohler Triton K-7401-2A

HC Lavatory Faucet            Kohler Triton K7437-K

Service Sink                      Kohler Whitby K-6710

Drinking Fountain              Elkay #EZSTL8C (twin station wall mount)

Apron for DF                    Elkay #LKAPREZL

## West Texas A&M University

Water Piping, above grade in buildings

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

Fittings: ASME B16.22, wrought copper.

Joints: ASTM B32, solder, Grade 95TA.

Waste lines from waterless urinals shall **NOT** be copper.

For Pipe sizes 2 inch to 4 inch:

Press Fittings: ASME B16.18 or ASME B16.22 copper and copper alloy press fittings conforming to IAPMO PS 117, with EPDM sealing ring factory installed in fitting.



## **General Information**

The design of the mechanical system and other building components shall be integrated together to produce a building that meets the project programmed functional, sustainable and energy requirements. Mechanical systems must be coordinated with all other building systems and features. Mechanical systems in new buildings shall be designed to exceed the minimum performance requirements of ASHRAE 90.1-2010 by 14 % and in existing building renovations exceed ASHRAE 90.1-2010 by 11% and incorporate cost effective energy conservation measures that do not compromise building performance or occupant comfort. Mechanical systems must be maintainable and all components reliable. The mechanical design and installation of all components and equipment shall allow for eventual removal and replacement.

All mechanical system components shall be manufacturers' standard commercial product. A standard commercial product is a product that has been sold for a period of at least three years on the commercial market, is listed in the manufacturers' catalogs and brochures and represents the latest production models.

HVAC systems shall be designed to allow systems to be scheduled off or set-back during unoccupied hours, weekends, and holidays. Allow a small AHU with O/A to be scheduled on to maintain positive building pressure. VAV boxes will be tied to lighting occupancy sensors to allow for zero air flow in unoccupied rooms when lights are off.

The GC/CM is responsible for creating a model using BIM authoring software. All clearances required for maintenance, repair, and adjustment shall be shown for coordination purposes. All mechanical equipment shall be labeled using parametric objects in the model. These labels shall be unique to each piece of equipment. The minimum parametric data required for each piece of equipment is room number (should be automatically generated), manufacturer, model number, and type of equipment. The type of equipment shall be easily identifiable by the object's name. Care shall be taken to reduce the various sizes of equipment particularly pumps that perform the similar tasks. This will help reduce the various spare parts that need to be stocked to maintain the building.

The model shall be used to derive shop, installation, and as-built drawings.

Label major mechanical equipment with a permanently affixed label containing equipment identification number or bar code as assigned by the facility management software.

System designs shall be evaluated by the design team on the basis of total ownership and operations cost over a period of twenty (20) years, not energy or capital cost alone. Submission of owning and operation cost analysis shall be required at the completion of Design Development phase.

**Design Criteria**  
**Division 23 – Heating, Ventilating and Air Conditioning**

1. Underground piping to be self restrained ductile iron preinsulated.
2. All valves on underground piping shall be ductile iron butterfly.
3. All gaskets shall be E.P.D.M.
4. All above ground piping to be type L copper or schedule 40 A53 black pipe.
5. All pressure piping shall be tested at 150 psi or greater for 4 hour minimum.
6. All hangers shall be hot dipped galvanized in the crawl space and wet areas and cad plated otherwise.
7. All ball valves shall be two piece threaded 600 with stainless steel ball and stem.
8. All gate valves to be rising stem.
9. All ducts to be fabricated from G-90 galvanized materials.

### **Ductwork**

All spin-ins shall be of the conical type with damper shaft mounted horizontally.

All grilles shall be regulated by a volume damper, when possible, in lieu of an OBD.

All metal components on galvanized sheet metal ducts shall be galvanized materials such as angle stiffeners. Trapeze hangers, rods, straps, etc.

All exposed ductwork to have internal insulation and metal liner and be fabricated from paint grip metal. The use of fiberglass internal duct liner is prohibited

Provide hangers for all slot diffusers and insulate. Provide detail on drawings.

Provide hinged access doors for duct access.

Provide required upstream straight duct for all air flow measuring station.

Provide air foil turning vanes.

All large round duct to be hung with half-round saddles and rods. Cable hangers are NOT acceptable.

Provide cover plates with appropriate finish for all recessed damper operators.

Provide a duct leakage test procedure.

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

Verify **ALL** return air paths.

Verify that there are sufficient dampers in the system to operate as specified, e.g. economizer.

Foil backed tape on ducts is not permitted. Use fiberglass and Benjamin Foster sealant with fiberglass mat embedded in sealant.

All exterior duct insulation shall have a vapor seal and metal jacket applied with fiberglass mesh installed and resealed with vapor barrier sealer.

### Metering

All buildings shall be designed for metering of campus thermal utilities. All auxiliary areas in a building shall be piped in a manner to allow sub-metering.

### Piping

In-line pumps are not to be used except for small fractional horsepower circulators.

Piping shall not be buried beneath the lowest floor level except for soil pipe. Piping will not be run in concrete floors. If pressure piping placement under slabs is unavoidable then the piping must be run in a steel pipe sleeve so leakage can be channeled off.

All condensate drain lines shall be insulated to the vertical main. In exposed areas insulation shall be premolded. In unexposed areas the insulation can be foil wrapped.

All hangers on domestic water and hydronic lines shall be installed on the exterior of the insulation.

3/4" is the smallest size for a hydronic pipe to a coil.

All ball valves on insulated piping to have extension handles.

Provide metal jacket on all crawl space piping, exterior insulate piping and mechanical room piping (up to 8'-0" AFF) insulation.

Density of fitting for insulated piping shall be the same as the specified pipe insulation. Use pre-molded fitting insulation, and loose fill are not acceptable.

All auto air vents shall be constructed with a cast iron body and stainless steel ball and seat.

All manual air vents shall be plugged.

## **Design Criteria**

### **Division 23 – Heating, Ventilating and Air Conditioning**

All valves preceding pressure gauges shall be needle type with snubbers installed on the discharge side of the pump.

Do not use red rubber gaskets on hot water lines and heat exchangers. Instead use EPDM or hard Garlock gaskets. Use EPDM gaskets in "push on" joints.

Anchor all condensate lines to floor. Do not gang condensate lines together.

Require high density polyethylene HPDE jacket or high density polyurethane polymer jacket on preinsulated piping. Provide insulation on all chilled water pumps and air separators.

Do not use gate valves in hydronic piping, use ball valves 2" and smaller (e.g. stainless steel ball and stem) and butterfly valves for 2-1/2" and larger.

Butterfly valves shall have ductile iron disc and stainless steel nosing and stem.

Ball valves (HVAC and Plumbing) to have stainless steel balls and stem.

All hangars and associated hardware in crawl spaces, under foundations, and in wet areas shall be hot dipped galvanized. Otherwise, hangars and hardware shall be cadmium plated.

For hydrostatic pressure tests, they are to be performed at either 150psi or 1.5 times the operating pressure, whichever is greater. The pressure tests are to have a minimum duration of four (4) hours.

### **Mechanical Equipment Rooms**

Access to equipment rooms shall be direct from hallways. Do not provide entrance through other rooms.

Special attention must be given to control the effects of sound and vibration from mechanical equipment to surrounding spaces.

Provide a curb around all penetrations through the mechanical room floor and all penetrations shall be sealed with appropriate fire stopping material.

Depress the floor of all mechanical rooms 1-1/2" and uniformly slope entire floor to minimum 4 inch floor drain(s). All floor drains to have trap primers and be connected to building sanitary sewer system

Provide positive ventilation in all equipment rooms that are not return air plenums.

Equipment rooms with other equipment than those items directly related to air handling equipment will not be used for return air plenums. The use of rooms as

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

plenums is permissible provided outside air and return air are directed to the plenum and volume control dampers are provided to control the quantity of each entering the plenum. Each component of an air handling system shall be spaced so there is ample room on all sides for inspection and maintenance (filter removal, bearing replacement, coil replacement, cleaning, etc.) and man sized hinged access doors shall be provided for ready access to the spaces in the air handling equipment. These required clearances shall be included in the BIM for coordination.

Air handlers suspended must be provided with permanent platforms for maintenance. The maintenance platform must be a minimum of 7'-0" clear from floor below.

Provide dedicated 120 VAC duplex electrical outlets for maintenance equipment, and separate mechanical keying with University master keying system.

Provide conditioned, supply air into each mechanical room and electrical room for tempering the air in the space. This may be accomplished with a “spin-in” and manually adjustable damper and branch duct or a variable air volume terminal located in the room.

### Flow Diagrams

A basic flow diagram indicating major components for pressurized circulating water systems and air systems will be provided with the Design Development submittal. Detailed flow diagrams to include all line sizes, in-line devices (valves, strainers, control valves, thermometers, pressure gauges, flow measuring devices), and flow quantities for headers and branch lines will be provided in the Construction Documents phase.

### Space Conditioning

Provide comfort conditioning winter and summer for all spaces except mechanical spaces. HVAC systems are to be selected, zoned, and designed to efficiently and effectively control the heat and humidity gain (or loss), and gains due to lighting, equipment, personnel, other special loads, and building exposures. Provide a separate system for areas where timing of functional uses may so require.

The Project A/E shall consider systems such as: Variable air volume air distribution, variable speed pumping, dedicated outdoor air handlers to meet the Indoor Air Quality requirements of ASHRAE Standard 62 (*Ventilation for Acceptable Indoor Air Quality*), Newer ASHRAE Standard energy recovery systems, high efficiency equipment and other accepted and normally utilized strategies to provide an energy efficient building. The Project A/E should be aware of the potential for mold and mildew problems in the humid climate at many of the campuses.

Consider not designing systems that require remote reheat piping to terminal boxes, design systems that locate all water piping in the mechanical rooms, consider dual duct,

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

or multi-zone systems.

Varied levels of air filtration will be required in the building. Give consideration to design features to provide good indoor air quality (IAQ). In addition to filtration, these features would include double wall air handlers with stainless steel drain pans sloped to drain, exterior duct insulation, and provisions for access for duct cleaning

The A/E shall require controls contractor to supply one, or more, temperature-sensing element(s) in each Air Handling Unit. The sensor shall be required to be installed in a serpentine manner so that at least 75% of the coil's surface is covered and a representative average temperature can be transmitted to the Energy Management System (EMS). The length of sensor should be one (1) foot of length per square foot of coil area. Air Handling Units' condensate drain pans shall be constructed of stainless steel, pitched two ways per Code, with a minimum 1½" drain connection.

### Ventilation

Provide power ventilation for restrooms, custodial areas, copy rooms, mechanical spaces, student and research laboratories, building crawl space, as well as other areas where required if there is the possibility of excess heat build-up, as required by code, and by the intended use of the space. The Design Team shall consider the efficiency of the ventilation equipment in their design.

### Laboratory Design

The primary objective in the design of HVAC Systems for laboratories is to provide a safe environment for laboratory personnel to conduct their work.

General laboratories shall typically have a maximum of 8 and a minimum of 4 air changes per hour. Lighting occupancy sensors shall detect occupancy and operate the lights and adjust ACH based on occupancy.

Laboratories must be maintained under negative pressure in relation to the corridor of other less hazardous spaces.

Fume hoods should not be the sole means of room exhaust. General room exhaust shall be provided to maintain air change rates and temperature control. Install variable speed exhaust fans, do not use constant speed fans with by-pass dampers.

Operable windows are prohibited in laboratories.

Type 316 stainless steel should be used for all parts of the fume hood exhaust system. The exhaust duct should have as few bends as possible and minimal horizontal runs.

The design of the laboratory ventilation system should follow the low pressure drop

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

design concepts developed by Laboratories for the 21th Century.

Fume hoods shall maintain a minimum face velocity of 100 fpm with no measure point less than 80 fpm when the sash is open 18 inches. When the sash is fully open the minimum face velocity shall be 100 fpm with the building lab air supply sized with a 60 % diversity factor.

#### Exhaust Fan Assembly:

The exhaust fan assembly shall be located on the roof or external to the building (penthouse?). The fan shall be either a mixed-flow dilution fan or industrial single width centrifugal type. Fan may be either belt-driven or direct drive, with motors isolated from the exhaust airstream and accessible from the fan exterior for inspection and service. Fan shall be AMCA 99 certified for Spark Resistant Construction. Fan shall be coated inside and out with coating suitable for products being conveyed. All fasteners shall be 316 stainless steel.

Fan and stack shall meet the requirements of ANSI Z9.5 for discharge velocity and stack height, unless a wind tunnel study can verify a lower discharge velocity or stack height will not be detrimental to occupants and air intakes for the building under design and the surrounding buildings.

Refer to Division 11 in the Facility Design Guidelines for additional fume hood requirements.

#### Acoustics

Provide sound traps in the ductwork, noise suppression devices in the design of piping and equipment and other acoustical or vibration control as required. Design Team shall provide all acoustic calculations a minimum of one week prior to the 100% Detailed Design for the noise levels at each air handling unit and mechanical room.

The Variable Air Volume (VAV) terminals and fan powered terminals shall be sized to have a room Noise Criteria (NC) rating so that the final discharge, or radiated sound pressure does not exceed the recommended values in Table 11 of Chapter 7, Sound and Vibration, of the 2001 American Society of Heating, Refrigerating, Air-Conditioning Engineers, Inc. (ASHRAE) Fundamentals Handbook.

Fan powered terminals shall be located outside of any noise sensitive areas. Refer to Requested Facilities section for identification of specific areas. More stringent criteria may be required in some areas.

Corresponding requirement for sound attenuation shall apply to the Variable Air Volume (VAV) terminals and fan powered terminals serving these areas.

## **Calculations for HVAC Design**

Submit cooling and heating load calculations for each individual zone in the building's HVAC system and sizing data for all applicable proposed equipment such as air handling units, VAV terminals, boilers, fan/coils, pumps, etc. for piping systems along with the 50% Construction Documents submittal. Also, provide representative "cut sheets" for equipment and materials.

Each zone calculation shall indicate, at a minimum: individual rooms, total and sensible loads, and air flow requirements. The heating and cooling loads shall represent all loads: people loads (including diversity factors), appliances, fresh air for ventilation in accordance with ASHRAE Standard 62.1, and external loads (e.g. solar and fenestration). Calculations shall be performed using a standard HVAC load calculation program such as: Elite Software's CHVAC, DOE2, Carrier's E20 or HAP, Trane Tracer, or other software regularly used and accepted in the HVAC industry.

The engineer shall submit necessary calculations to verify the design meets the requirements of ASHRAE Standard 62.1. This shall be in the form of calculations indicating that the necessary outside air is supplied to each system, or zone, to comply with the requirements of the ASHRAE Standard. Where the engineer utilizes diversity factors and the multiple spaces portions of the Standard to supply the required outdoor air for ventilation, he must also submit documentation verifying the requirements of the Standard are met.

## **Mechanical and Electrical General**

Room numbers must appear on air conditioning and electrical plans and room names where space is available. Column lines or designations shall appear on all MEP sheets as they appear on Architectural sheets.

Plumbing and air conditioning systems shall be drawn as separate drawings. These systems may be combined on common drawings only by written permission of the FPC Project Manager.

Where piping systems are to be installed underfloor, these shall be shown on an underfloor plan and not on the plan prepared for the space above. Floor plans for mechanical systems shall be drawn to show pipes, ducts, etc. on the floor in which they are installed. In general, underfloor plans shall be drawn to show all piping underfloor and, from there up, the systems between each floor slab shall be shown only on the appropriate floor plan.

All construction details shall be shown on the drawings and shall not be bound in the specifications.

All equipment and material specifications shall be bound in the specifications and shall



## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

not be shown on the drawings.

Performance data for all mechanical and electrical equipment shall be attached to objects as parametric data. The data shall be used to derive schedules on the drawings. The data may also be included in the project specifications. Data shall be linked between the object and schedule to ensure that the correct data is updated at all locations.

The A/E shall identify on the drawings all areas that may be classified as hazardous in accordance with the latest edition of the NFPA Code or that may pose a health hazard due to noise levels, radiation, chemical fumes, etc. The A/E shall describe how each such area will be treated in the building design.

The A/E shall design the facility to connect to the central utility systems as available and as directed in the POR.

### Design Conditions

The following information should be clearly shown on the General Information Sheet. Additions and deletions may be required if package unit equipment is incorporated in the design of facilities.

|                                |   |
|--------------------------------|---|
| Mechanical                     |   |
| Summer Outside                 | (°F.D.B.) (°FWB)                        |
| Summer Inside                  | (°F.D.B.) (%R.H.)                       |
| Winter Outside                 | (°F.D.B.)                               |
| Winter Inside                  | (°F.D.B.)                               |
| Total Cooling Capacity         | (Tons) Total Connected load of Building |
| Total Cooling Max. Demand      | (Tons)                                  |
| Total Heating Capacity         | (BTUH) Total Connected Load of Building |
| Total Heating Max. Demand      | (BTUH)                                  |
| Chilled Water                  | (gpm)                                   |
| Heating Water                  | (gpm)                                   |
| Fresh Air Req'd, Winter        | (cfm)                                   |
| Summer                         | (cfm)                                   |
| Domestic Hot Water, Capacity   | (gpm)                                   |
| Domestic Hot Water Max. Demand | (gpm)                                   |
| Steam, Capacity                | (#hr)                                   |
| Steam Max. Demand              | (#hr)                                   |
| Condensate, returned           | (gph)                                   |
| Fixtures (plumbing)            | (fixture units)                         |
| Sanitary Sewer                 | (gpm)                                   |
| Gas, natural                   | (cfh)                                   |

Determine the economic feasibility of incorporating solar energy for space heating,

cooling, and water heating into the building design and proposed energy system.

Economic feasibility for each function shall be determined by comparing the estimated cost of energy procurement using conventional sources and energy systems with the estimated cost of using solar energy during the economic life of the proposed building.

## **Boilers**

Specifications for boilers to include the following:

1. Chemically treat and flush boiler system prior to initial startup.
2. Begin internal boiler treatment with chemical comparable with JD-701 (Fort Bend Services).
3. Provide and install an automatic blow down system.
4. Provide and install a conductivity meter.
5. Provide and install means for future chemical treatment.

## **Hydronic Piping Cleaning Guidelines**

- Cleaning and Flushing of piping systems must be done by an independent, third party company that specializes in this type of work
- Submit detailed plan for Engineer's and Owner's review and approval prior to any piping being installed. Plan shall describe in full detail the individual steps associated with this process before any piping is installed. Plan must include a drawing indicating phasing of systems to be cleaned, locations of drains or other temporary connections required for cleaning system, recommended time for cleaning agent circulation and clean water flushing, and cut sheet of proposed temporary pump(s).
- Clean and flush thoroughly to remove construction debris (e.g., rust, dirt, piping compound/dope, mill scale, oil, grease) and contamination before placing pipe in service. Provide necessary temporary connections, bypass piping or hoses and valves that are required for cleaning, purging and circulating. Provide temporary bypasses around AHUs, fan coil units, and cooling and hot water coils. Bypasses are to be the same size as the supply and return pipe size. Also, do not flush through chillers, cooling towers, pumps, or other equipment. Remove flow meters from building piping prior to cleaning/flushing operation.
- Cleaning & Flushing fluid velocities are to achieve a minimum velocity of 10 ft/sec to achieve a thoroughly clean system, free of construction debris and contamination before placing piping systems in service
- Cleaning chemicals/agents must be environmentally friendly. Submit chemical cut sheets to Owner for approval prior to cleaning.
- Third party is to provide their own temporary pumps and connections as required to achieve minimum velocities for cleaning, purging and circulating. Likewise, third party is to provide temporary strainers necessary to protect sensitive equipment and components during cleaning/flushing process.

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

- Install temporary strainers in front of pumps, tanks, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the cleaning and flushing process has ended and the system has been deemed clean and ready for use. Then remove the entire strainer or strainer element only. Replace the strainer basket and gasket. Contractor shall notify Owner so that the reinstallation of clean strainer screens may be witnessed.
- Do not flush thru our coils (AHUs or air boxes) – normally only up to the isolation valves.
- Discharge the “dirty” water to the sanitary waste stream – NOT the storm drains.
- After systems have been cleaned and flushed, third party to provide a written certification that the systems are clean and ready for use.

## Campus Specific Information

### Texas A&M University

Mechanical systems shall be designed to exceed the minimum performance requirements of ASHRAE 90.1-2010 by 18% in new construction, and 14% in existing building renovations. Additionally, all projects are required to earn 5 points within EA credit 1, under the USGBC’s LEED 2009 rating system

### Chilled Water (CHW) and Heating Hot Water (HHW) Systems

#### CHW and HHW Supply Temperature Reset

The Utilities and Energy Management Department at Texas A&M University is actively identifying and implementing strategies to reduce the energy consumption and cost associated with campus heating and cooling requirements while ensuring customer needs are consistently met. Chilled water (CHW) and heating hot water (HHW) supply temperature reset schedules have been in effect on the campus for many years, with supply temperature adjusted based on outside air temperature. The supply temperature for chilled water ranges from 42 to 46 Degrees F and the supply temperature for heating hot water ranges from 130 to 170 Degrees F. The supply temperature reset schedule charts for both CHW and HHW are included.

#### HVAC Coil Design Delta T

All CHW cooling coils in facility air handling units (AHUs) and fan coil units (FCUs) shall have a minimum of 14 Degrees F design delta T based on a CHW supply temperature of 42 Degrees F, during peak cooling periods, except for spaces with high internal heat loads, such as server rooms. In spaces with high internal heat load, the system should be designed to meet maximum cooling requirements with a CHW supply temperature of 46 Degrees F.

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

For HHW, the minimum AHU and FCU design delta T shall be 30 Degrees F based on a design HHW Supply Temperature, during peak heating periods, of 170 Degrees F. The minimum coil design delta T's specified above are contingent upon maintaining proper coil flow tolerance per 2008 ASHRAE Handbook, pg 12.18, Fig. 34. Coil design delta T (for both CHW and HHW) can be higher than indicated above, but this design requirement must be achieved, unless a modification to this design guideline is approved in advance as indicated at the end of this guideline. Coils shall be designed in accordance with the latest version of ARI Standard 410.

AHUs having greater than 50 percent outside air supply shall have an energy recovery system incorporated into the design, unless it is proven to not be justifiable based on a life cycle cost analysis. Energy recovery systems shall be designed to operate at a minimum of 70% efficiency and be connected to the Siemens BAS to allow for effective monitoring of the system operation. Pre-filters shall be provided on all energy recovery systems to prevent fouling of the heat transfer element.

A requirement for testing, balancing and commissioning of both water and air flow shall be included in the specifications for all HVAC systems installed in new buildings and with any significant HVAC system replacement or retrofit.

#### CHW and HHW Distribution Systems

CHW and HHW distribution pumps in the buildings shall be equipped with variable speed drives, with pump speed modulated to maintain sufficient differential pressure at desired flow through all HVAC coils in the building. Variable speed drives shall be connected to the Siemens BAS for effective monitoring and control under all flow conditions. The Siemens BAS shall also monitor the status of CHW and HHW control valves and any valve which hasn't opened a minimum of 20% at least once during any 168 hour (one week) period shall be programmed by the BAS to automatically open fully (during unoccupied periods) for a period of 15 minutes, in order to flush the thermal piping and minimize the potential for microbial growth.

All AHU and FCU fan motors and CHW and HHW pump motors installed in new buildings and with major system replacement or retrofit shall be specified to meet minimum efficiency requirements of National Electrical Manufacturers Association (NEMA) Standards Publication MG1-2006 (or any later edition) Premium Energy Efficiency Motor Standard, if a Premium Energy Efficiency Motor is available in the required size and rating. All new motors shall be sized to operate with a load factor of between 65 and 100 percent.

Three-way bypass control valves shall not be installed in any new CHW or HHW system. When HVAC systems in existing buildings are upgraded to include direct digital control (DDC), all existing three-way bypass control valves shall be removed and the DDC control system shall be programmed to provide flushing as previously described.

## Design Criteria

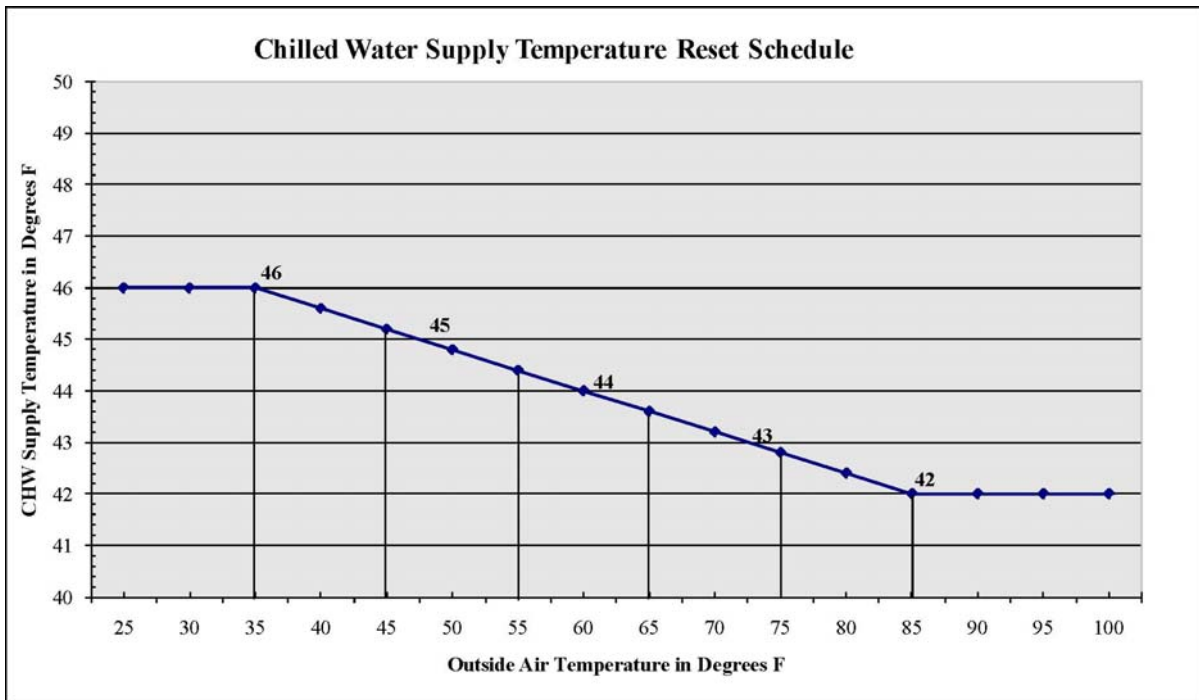
### Division 23 – Heating, Ventilating and Air Conditioning

Two-way characterized ball-style control valves shall be used for CHW and HHW flow control, rated to handle pressure drop that exceeds the highest differential pressure that the distribution pump(s) can generate, in order to avoid valve seat deterioration and leak-by. Control valve actuators shall have shut-off ratings that exceed the highest potential branch circuit differential pressure to ensure positive valve closure. Electric valve and damper actuators shall be specified for all HVAC systems that have DDC capability.

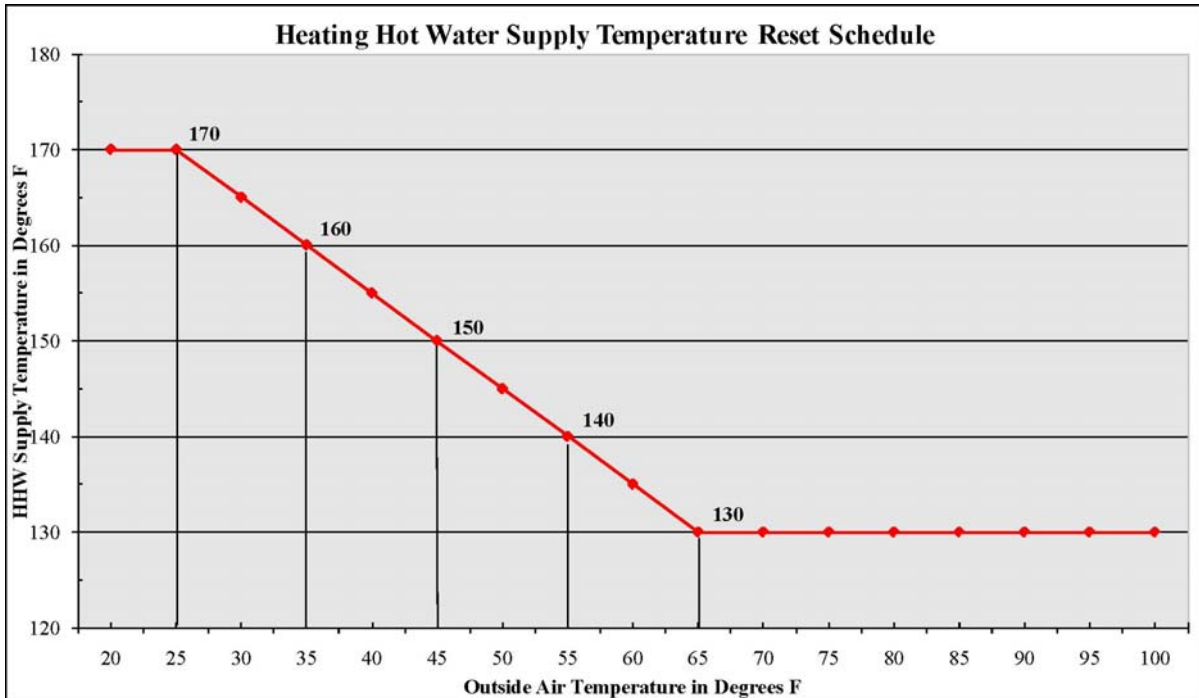
See the Design Guide Specification for Automatic Temperature Controls and Energy Management Systems in Division 25 of the Facility Design Guidelines for HVAC system requirements.

Any deviation from this design guideline needs to be reviewed and approved by both Engineering Design & Construction Services (EDCS) in the Facilities Services Department and Utilities & Energy Management (UEM) Department

#### CHW & HHW SUPPLY TEMPERATURE RESET SCHEDULES



**Note:** CHW supply temperature range is 42 to 46°F with reset based on outside air temperature. Actual loop temperature may vary +/-1°F from target.



**Note:** HHW supply temperature range is 130 to 170°F with reset based on outside air temperature. Actual loop temperature may vary +/-5°F from target.

## Metering

Chilled Water: The meter shall be the type manufactured by Rosemount under the product umbrella “Rosemount 8705 Magnetic Flow Meter”. All meters should be equipped with a Rosemount remote transmitter model 8712. Meter should be installed per the manufactures specifications and should be field verified by Utilities and Energy Management personnel. Approval from the Utilities and Energy Management must be obtained before sizing the flow meter to ensure it is within allowable flow ranges. There will need to be two immersion well temperature sensors of the type manufactured by Minco 100 Ohm Platinum with a temperature range of 30 deg.f. to 80 deg.f. which corresponds to a 4-20 mA output. One sensor will be installed in the primary CHW supply and one sensor will be installed in the primary CHW return piping. Flow wiring from the transmitter will be run to the WAGES PLC.

Heating Hot Water: The meter shall be exactly like the type manufactured by Rosemount under the product umbrella “Rosemount 8705 Magnetic Flow Meter”. All meters should be equipped with a Rosemount remote transmitter model 8712. Meter should be installed per the manufactures specifications and should be field verified by Utilities and Energy Management personnel. Approval from the Utilities and Energy Management must be obtained before sizing the flow meter to ensure it is within allowable flow ranges. There will need to be two immersion well temperature sensors of the type manufactured by Minco 100 Ohm Platinum with a temperature range of 65 deg.f. to 190 deg.f. which corresponds to a 4-20mA output. One sensor will be installed in

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

the primary HHW supply and one sensor will be installed in the primary HHW return piping. Flow wiring from the transmitter will be run to the WAGES PLC.

Steam Meter: The meter shall be exactly like the type manufactured by Rosemount under the product umbrella “Rosemount 3095 Mass Proplate Flowmeter”. Meter should be installed per the manufactures specifications and should be field verified by Utilities and Energy Management personnel. Approval from the Utilities and Energy Management must be obtained before sizing the flow meter to ensure it is within allowable flow ranges. Flow wiring from the transmitter will be run to the WAGES PLC.

Natural Gas Meter: The meter will be supplied by the local distribution company

### Central Plant Utility Systems

The Texas A&M University Utilities and Energy Management produces and distributes all of the utility services required by academic, general purpose and research facilities. The following are design criteria for the central utilities systems which should be used in the design of building systems which are connected to the central system.

Chilled Water: Shall not be used for any purpose other than comfort space conditioning.

Chilled Water temperature is reset based on outside air temperature.

- O/A less than 40 deg.f.      CHW = 48 deg.f.
- O/A from 40 to 50 deg.f.      CHW = 46.5 deg.f.
- O/A from 50 to 60 deg.f.      CHW = 45 deg.f.
- O/A from 60 to 70 deg.f.      CHW = 43.5 deg.f.
- O/A greater than 80 deg.f.      CHW = 42 deg.f.

Consult Texas A&M Utilities and Energy Management for supply and return pressure data.

Heating Water: Shall not be used for any purpose other than comfort space conditioning.

Heating Hot Water temperature is reset based on outside air temperature.

- O/A less than 30 deg.f.      HHW = 180 deg.f.
- O/A from 30 to 40 deg.f.      HHW = 170 deg.f.
- O/A from 41 to 50 deg.f.      HHW = 160 deg.f.
- O/A from 51 to 60 deg.f.      HHW = 150 deg.f.
- O/A greater than 60 deg.f.      HHW = 140 deg.f.

Consult Texas A&M Utilities and Energy Management for supply and return pressure data.

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

Domestic Hot Water: Consult Texas A&M Utilities and Energy Management for pressure and temperature data.

Large users shall be connected to central system if in close proximity to existing distribution system. Small users may generate their own domestic hot water with gas or electric heaters. Heating water shall not be used as the heat source in producing domestic hot water.

Compressed Air: Consult Texas A&M Utilities and Energy Management for the availability of centrally produced compressed air for laboratory and instrumentation usage. Do not use for space conditioning instrument except as back-up for reliability.

Steam: Consult Texas A&M Utilities and Energy Management for the availability of centrally produced steam.

Condensate: Consult Texas A&M Utilities and Energy Management for condensate return data.

Domestic Water: Consult Texas A&M Utilities and Energy Management for pressure data.

Sanitary Sewer: All buildings with sanitary facilities will be tied into the sanitary sewer system.

Project A/E shall consult with and obtain the approval of the Department Head of System Member Environmental Health & Safety Department, Department Head of System Member Utilities and Energy Management Department and Director of Project Delivery, Facilities Planning and Construction prior to the anticipated used of the sanitary sewer system for the disposal of animal waste.

Storm Sewer: Used exclusively for rainfall run-off.

## Prairie View A&M University

### Central Plant Utility Systems

The Prairie View A&M University Utilities Plant produces and distributes the following utility services required by academic, genral purpose and research facilities. The following are design conditions for these systems.

Chilled water: Shall not be used for any purpose other than comfort space conditioning.

|         |                                       |
|---------|---------------------------------------|
| Supply: | Pressure: 60 psi Normal, 95 psig Max. |
|         | Temperature: 43°                      |



**Design Criteria**  
**Division 23 – Heating, Ventilating and Air Conditioning**

Return:                      Pressure:     45 psi  
                                    Temperature: 54°F

Domestic Hot Water: Large users shall be connected to central system unless otherwise specified in Program of Requirements. Small users shall generate their own Domestic hot water utilizing steam as the heat source.

Pressure:                    60 psig Max., 50 psig Normal  
Temperature:                140°F

Steam:

Pressure:                    150 psig and 15 psig  
Temperature:                550°F Max., 365°F Normal and 365°F Max., 250°F Normal.

Condensate:

Return Header Pressure:    15 psig

Domestic Water:

Pressure:                    54 psig

Sanitary: All buildings will be connected to this system. Do not use for storm drainage.

Storm Sewer: Used exclusively for rainfall run-off. Buildings shall have roof drain systems conveyed to underground storm sewers.

## **Tarleton State University**

### **Central Plant Utility Systems**

The Tarleton State University Utilities Department provides the following utility services required by academic, general purpose and research facilities. The following are design and general conditions for these systems.

Steam:

Pressure:                    20 psig  
Temperature:                259°F

**Design Criteria**  
**Division 23 – Heating, Ventilating and Air Conditioning**

Condensate:

Return Header Pressure: Gravity

Domestic Water:

Pressure: 55 psig

Sanitary Sewer: All buildings will be connected to this system. Do not use for storm drainage.

Storm Sewer: Used exclusively for rainfall run-off. Buildings shall have roof drain systems conveyed to underground storm sewers.

## **Texas A&M University at Galveston**

### **Central Plant Utility Systems**

The Texas A&M University at Galveston Utilities Department provides the following utility services required by academic, general purpose and research facilities. The following are design and general conditions for these systems.

Chilled Water: Shall not be used for any purpose other than comfort space conditioning.

Supply: Pressure  
Temperature: 45°F

Return: Pressure  
Temperature: 56°F

Heating Water:

Supply: Pressure  
Temperature: 180°F

Return: Pressure  
Temperature: 150°F

Domestic Water:

Pressure:

Sanitary Sewer: All buildings will be connected to this system. Do not use for storm drainage.

Storm Sewer: Used exclusively for rainfall run-off. Buildings shall have roof drain systems conveyed to underground storm sewers.

## **West Texas A&M University**

### **Chilled Water Piping:**

Steel Pipe: ASTM A53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black.

2 inch and Smaller:

Fittings: ASTM B16.3, extra heavy malleable iron class 250 or ASTM A234, forged steel welding type.

Joints: Threaded or AWS D1.1 welded.

2-1/2 inches and larger – in mechanical rooms and crawl spaces.

Mechanical Grooved Fittings: ASTM A536 ductile iron, grade 65-45-12

Mechanical Grooved Couplings: ASTM A-536 Ductile iron housing clamps to engage and lock, "C" shaped EPDM elastomeric sealing gasket, steel bolts, nuts, and washers.

2-1/2 inches and larger – in concealed spaces, above finished spaces, and all connecting piping to air handling units.

**Fittings: ASTM A234 forged steel welding type, Class 300.**

Joints: AWS D1.1 welded.

### **Heating Water Piping:**

2-1/2 inches and larger:

Steel Pipe: ASTM A53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black.

2-1/2 inches and larger – in mechanical rooms and crawl spaces.

Mechanical Grooved Fittings: ASTM A536 ductile iron, grade 65-45-12

Mechanical Grooved Couplings: ASTM A-536 Ductile iron housing clamps to engage and lock, "C" shaped EPDM elastomeric sealing gasket, steel bolts, nuts, and washers.

2-1/2 inches and larger – in concealed spaces, above finished spaces, and all connecting piping to air handling units.

**Fittings: ASTM A234 forged steel welding type, Class 300.**

Joints: AWS D1.1 welded.

2 inches and smaller:

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

Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.

Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

For copper Pipe sizes 3/4 inch to 2 inch:

Press Fittings: ASME B16.18 or ASME B16.22 copper and copper alloy press fittings conforming to IAPMO PS 117, with EPDM sealing ring factory installed in fitting.

#### **Medium and High Pressure Steam Piping (150 PSIG Maximum)**

Steel Pipe: ASTM A53, Schedule 80, black.

Fittings: ASTM B16.3 malleable iron Extra Heavy

Joints: AWS D1.1 welded.

#### **Low Pressure Steam Piping (15 PSIG Maximum)**

Steel Pipe: ASTM A53, Schedule 40, black.

Fittings: ASTM B16.3 malleable iron Extra Heavy

Joints: AWS D1.1, welded.

#### **Medium and High Pressure Steam Condensate Piping**

Steel Pipe: ASTM A53, Schedule 80, black.

Fittings: ASTM B16.3 malleable iron, Extra Heavy

Joints: Up to 1 inch: Threaded, or AWS D1.1, welded for all piping above 1 inch.

#### **Low Pressure Steam Condensate Piping**

Steel Pipe: ASTM A53, Schedule 80, black.

Fittings: ASTM B16.3 malleable iron Extra Heavy

Joints: Up to 1 inch: Threaded, or AWS D1.1, welded for all piping above 1 inch.

## **Guide Specification**

Testing, adjusting and balancing of the air conditioning system, related to ancillary equipment and the domestic water system will be performed by an impartial technical TAB firm selected and employed by the owner

### **Air Handling Units for Design & Construction**

1. Install thermometers and pressure indicators in the hydronic coil piping. Don't rely on the EMS to read these values.
2. Flushing the piping loop(s), primary and secondary, is essential for a dependable maintenance free system. The engineer, or his designate, should be present during the flushing. This will mean a good specification delineating the goals and the definition of what is an acceptable measure of what "a clean piping system" is.
3. Temperature sensors across coils. For best results, temperature sensors on coils should be sized for: In mixing plenums the length of the element should be two (2) feet in length for each square foot of coil area. In other applications the length of the element should be one (1) foot in length for each square foot of coil area.
4. Averaging-type sensors should be installed in a serpentine manner uniformly across the coil cross-section, with radius clips at each bend of the sensor in the coil supporting the sensor.
5. Multiple sensors can be wired in a series/parallel arrangement for complete coverage in plenums. As an alternative, for larger mixing plenums, it may be advantageous to install several analog-input points on the controller. This arrangement allows software averaging of temperatures for control while providing individual temperature indication to monitor stratification conditions with worse-case conditions triggering a software alarm.
6. Double wall casings are required on all air handling units. Gauge thickness shall be no less than 18 gauge exterior and 20 gauge interior. Insulation shall be a minimum of R-12 and conform to NFPA standard 90 requirements. All exterior wall panels shall be made of ASTM A653 G90 galvanized steel and built on a minimum of six inch rails. Units shall have access doors, minimum 15½" width, to access both sides of the coils, filters, fan section and mixing box sections.
7. Interior wall panels may be made of perforated ASTM A653 G90 galvanized steel for sound attenuation. However, other methods, i.e. external methods and devices, of sound attenuation are preferred.
8. Drain pans shall be of double wall construction with a stainless steel inner liner, sloped both ways to a single outlet with a minimum of 2" of uncompressed insulation,

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

with a minimum condensate connection of 1” NPT stainless steel. Drain pans shall extend downstream of the coil far enough to contain moisture carry-over. Drain pans must be accessible for inspection and cleaning.

9. Cooling coils shall contain a minimum of 6 rows, tube diameter of either ½” with a minimum .025” wall thickness or 5/8” with .028” wall thickness and maximum of 10 fins per inch, and fin thickness of not less than .006 inches.

10. Air handling units shall be constructed to facilitate easy removal of the coil without disassembly of the cabinet. At the manufacturer’s option, the coils may be installed on tracks to facilitate removal.

11. Coils shall comply with ARI Standard 410 for capacity, pressure drops and selection procedure. Where stacked coils are required in large units, the manufacturer shall provide for a means to collect and drain the condensate from the top coil to the drain pan without impingement on the lower coil.

12. If the campus is in excess of 50 miles of the Gulf coast coil tubing shall be copper with aluminum fins. If the campus is within 50 miles of the Gulf coast, tubes and fins shall be copper or, at the engineers’ option, heresite coated aluminum fins.

13. Coil casing shall be stainless steel for chilled water coils. Any penetrations shall have rubber grommets and fully sealed for pressurization and insulated from the casing insulation.

14. Bearings shall self aligning, antifriction type with a life of 200,000 hours of L-10 life with external grease fittings. All bearings shall be factory lubricated and equipped with standard hydraulic grease fittings and lube lines extending to the motor side of the fan.

15. All units with a motor rated at 10 horsepower and larger, shall be furnished with and internal 120 VAC marine light. Lights shall be a weather-resistant, gasketed, incandescent light. Air Handling Units shall also incorporate an inspection window constructed of glass reinforced with safety wire and installed in the fan section on the side from which the belt drives are visible.

16. All units shall have a single point of connection for the electrical service to the unit. The manufacturer shall seal the conduit to the motor with “Sealtite” to prevent condensation in the motor connection housing.

17. Safety latches shall be required on the fan section.

18. Minimum space between the coils in the air handling units shall be 15½” for cleaning coils.

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

19. Fans for air handling units shall be backward inclined or airfoil centrifugal type certified as complying with ARI 430-89. A/E shall specify the total static pressure and either the brake horsepower or impeller diameter. Fans shall be rated and certified in accordance with ARI Standard 430. All airfoil fans shall bear the ACMA seal. Fan Modulation – VFDs, dampers or inlet guide vanes are not acceptable. Fans shall have internal vibration isolation installed under the fan and motor.

20. Impellers shall be either aluminum or herisite coated. Motors shall be premium efficient rated for VFD operation shall be inverter duty type and capable of withstanding repeated peaks of 1600 volts at 0.1 microsecond rise time. Comply with NEMA MG-1 Part 31, where applied with and of type F insulation NEMA MG 1-10.38 with H rise.

21. Air handling unit installation shall utilize a method to measure the outdoor air flow rate and adjust the outdoor air flow rate to meet the ASHRAE 62-2001 standard. In addition, the A/E shall consider methods of controlling the systems to ensure compliance. For example, a “polling” system for VAV terminals and utilizing the EMS to comply with the ASHRAE 62-2001 standard.

22. Filters – Type, sizes, etc. shall be specified by the A/E and based on the individual application and use for the Air Handling Unit. Efficiency shall be specified by the “dust spot method” in accordance with ASHRAE Standard 52. Minimum efficiency shall be 30% unless otherwise approved by the System Mechanical Engineer. Consider a secondary filter of 60% efficiency.

23. There is a difference in design requirements for AHUs operating under positive pressure (blow through) and negative (draw through) pressure.

A positive pressure trap should have a weir depth of the total expected static pressure plus  $\frac{1}{2}$ ". This static pressure can be gauged based on the worst case of the fan being “deadheaded” at the full rated speed allowed by the Variable Speed Drive (VSD).

However, a negative pressure trap should have a total depth equal to: 1" for each 1" of maximum negative static pressure, an additional 1", the weir height, and the pipe diameter and exterior insulation. The weir height should be half of 1" for each 1" of maximum negative static pressure plus the additional 1".

Without a trap, or if the trap is improperly designed, air will be drawn into the inside of the fan and AHU casing. In a negative pressure situation, this results in water from the condensate pan spraying the inside of the unit. This will eventually result in damage to the equipment and mold and mildew growth.

In a negative pressure situation, if the trap is too tall or too short, water can be drawn back up into the condensate pan and result in flooding the interior of the unit or dry out allowing air intrusion and water spraying into the unit. Using the proper seal height will prevent these problems. The consultant shall not leave the trap design to the contractor.

## Guide Specification

### Variable Air Volume Terminal Units for Design & Construction

1. Casing - Terminals shall be constructed of a minimum 20 gauge G90 galvanized steel as per ASTM A 653, *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dipped Process*, capable of withstanding a 125 hour salt spray test as per ASTM B-117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*. Terminal casing shall be assembled with fasteners. Spot welded assemblies are not acceptable. Casing less than 36" wide min 22 gauge; greater than 36" min 20 gauge.

Internal Liner - Casing shall be internally lined with minimum 1" thick dual density (1.5 pounds per cubic foot with 4 pounds per cubic foot face) fiberglass insulation rated for a maximum air velocity of 3,600 feet per minute. Insulation shall be fastened with adhesive complying with NFPA 90A. The insulation shall also use spot welded "stick pins" to ensure the insulation is securely fastened. Using adhesive to fasten the insulation to the casing is not acceptable. Insulation minimum "U" value shall be 0.24 Btu/hr-ft<sup>2</sup>-°F. Insulation shall meet or exceed the requirements of UL 181 and NFPA 90A. Raw insulation must be covered with a metal liner to eliminate flaking of insulation during installation. Simple "buttering" of raw edges with an approved sealant is not acceptable.

Options -

Foil faced insulation – interior insulation shall be covered with scrim backed foil facing. All insulation edges shall be covered with foil or metal nosing. Insulation shall meet ASTM C 1136 *Standard Specification for Flexible Low Permeance Vapor Retarders for Thermal Insulation*, and ASTM 665 *Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing*, for biological growth in insulation.

Engineers shall specify terminals with a fiber-free close cell electrometric foam liner. (This is to be used for job specific laboratories) Liner shall not absorb water, be smooth, erosion resistant and washable. Liner shall be acoustically superior to standard dual density fiberglass insulation. Liner shall comply with the following Standards: *NFPA 90A – Supplementary materials for air distribution, ASTM E84 and UL 181 (25/50) Smoke and Flame spread, ASTM C1071, G21, and G22 no bacterial or fungal growth*

Control Assemblies, hot water heating coils, electric heating coils shall not extend beyond the top and bottom of the unit casing.

2. Maximum Static Pressure Drop - At the inlet velocity of 2,000 feet per minute, the static pressure drop across the basic terminal or basic terminal with a sound attenuator shall not exceed .08" w.g for all unit sizes.



**Design Criteria**  
**Division 23 – Heating, Ventilating and Air Conditioning**

3. Primary Air Valve - the primary air valve shall consist of a minimum 22 gauge cylindrical body that includes embossed rings for structural rigidity. The damper blade shall be connected to a solid shaft by means of an integral molded sleeve which does not require screw or bolt fasteners. The shaft shall be manufactured of a low thermal conducting *composite* material, and include a molded damper position indicator visible from the exterior of the unit. The damper shall pivot on self lubricating bearings. The damper actuator shall be mounted on the exterior of the terminal for ease of service. The valve assembly shall include internal mechanical stops for both full open and closed positions. The damper seal shall be secured without the use of adhesives. The air valve leakage shall not exceed 1% of maximum inlet rated pressure at 3.0" w.g. inlet pressure.

Air leakage thru the primary air valve shall not to exceed 2% (or 5%) of the nominal catalog flow at 3.0" w.g.

4. Airflow Sensor - Differential pressure airflow sensor shall traverse the duct using equal cross sectional area or log-linear traverse method along two perpendicular diameters. Single axis sensor shall not be acceptable for ducts 6" in diameter or larger. A minimum 12 total pressure sensing points shall be utilized. The total pressure inputs shall be averaged using a pressure chamber located at the center of the sensor. A sensor that delivers the differential pressure signal from one end of sensor is not acceptable. The sensor shall output an amplified differential pressure signal that is at least 2.5 times the equivalent velocity pressure signal obtained from a convention pitot tube. The sensor shall develop a differential pressure of 0.03" w.g. at an air velocity of 400 feet per minute. Documentation shall be submitted which substantiates this requirement. Brass balancing taps and airflow calibration charts shall be provided for field airflow measurements.

The airflow sensor shall be a cross, i.e. two sensor elements that are the full diameter of the inlet duct connection and at 90° to each other. Single axis sensors will not be acceptable. The sensor shall develop a differential pressure of 0.03" w.g. at air velocities of 450 feet per minute or less. Consultant shall require submittals certifying the sensors do have this capability.

5. Hot Water Coils - where required by the schedules or on the drawings and shall be included in the terminal. The coil shall be manufactured by the terminal unit manufacturer (or approved coil manufacturer) and shall have a minimum of 22 gauge galvanized sheet metal casing with a minimum G90 coating. Stainless steel casings, with a baked enamel paint finish, may be used as an alternative. Coil to be constructed of pure aluminum fins with full fin collars to assure accurate fin spacing and maximum tube contact. Fins shall be spaced with a minimum of 10 fins per inch and mechanically fixed to seamless copper tubes for maximum heat transfer. Each coil shall be tested at a minimum of 350 psig under water.

0.50" tube diameter with 0.017" wall thickness fins of 0.0045" thickness tested and certified in accordance with ARI Standard 410. Casing material. Specify who is to supply control valves, air vents and drain valves.

Engineer shall specify that any coil bends or parts exposed to the outside of the

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

terminal shall be insulated to prevent condensation.

6. Electric Resistance Heating Elements - where required by the schedules or on the drawings and shall be included in the terminal. Heater shall be manufactured by the terminal manufacturer (or approved coil manufacturer), and shall be ETL listed. The electric resistance heating element cabinet shall be constructed of not less than 20 gauge galvanized steel with a minimum G 60 zinc coating. Stainless steel casings or galvanized steel casings with a baked enamel paint finish may be used as an alternative. The electric resistance heating cabinet shall have a hinged access panel for entry to the controls.

The electric resistance heating element shall be factory installed to the terminal with heating elements located upstream of the airflow control damper to uniform velocity profile over elements. Elements located downstream of the damper are not acceptable.

An electrical disconnect shall be mounted on the terminal box and shall render the heater non-operable. Heater shall be furnished with all of the controls for safe operation and full compliance with the UL 1995 and the National Electric Code, latest edition.

Single point access for electrical and multiple access doors if they have more than one motor.

The electric resistance heating element cabinet shall have a single point electrical connection. The connection shall include a disc-type automatic reset high temperature limit, secondary high limit(s), airflow switch, Ni-Chrome elements, and fusing per UL and NEC. Heater shall have complete wiring diagram with label indicating power requirement and kw input.

7. If the Consultant determines sound attenuators are required, it shall be provided and scheduled on the drawings to meet acoustical performance requirements. The attenuator and terminal unit shall be of single piece construction. Attenuator shall be constructed the same as the base terminal. Terminals shall meet the requirements of ARI Standard 885-98 for sound.
8. Multi-Outlet Plenums - if the Consultant determines a multi-outlet plenums are required, they shall be provided where scheduled on the drawings. The multi-outlet plenums shall have balancing dampers at each outlet with a locking quadrant. Multi-outlet plenums shall be constructed the same as the base terminal.
9. Fans - fan powered terminals shall be utilize a forward curved, dynamically balanced, galvanized wheel with a direct drive motor. The motor shall be permanent split capacitor type with three separate horsepower taps. Single speed motors with electronic speed controllers are not acceptable.

The fan motor shall be unpluggable from the electrical leads at the motor case for simplified removal (open frame motors only). The motor shall utilize permanently lubricated sleeve type bearings, include thermal overload protection. The motor shall be mounted to the fan housing using torsion isolation mounts properly isolated to minimize vibration transfer.

## Design Criteria

### Division 23 – Heating, Ventilating and Air Conditioning

The terminal shall utilize an electronic (SCR) fan speed controller for aid in balancing the fan capacity. The speed controller shall have a turn down stop to prevent possibility of harming motor bearings.

Options –

1. The Consultant shall examine and determine if the use of ECM motors for the terminals can be economically justified. The terminal shall include a rectifier and filter for AC power to condition the power to the fan.
  2. If the use of ECM motors requires additional electrical circuiting or grounding, the design electrical engineer shall notify the design mechanical engineer in writing. The Texas A&M University System Mechanical and Electrical Engineers shall also receive this notification. Prior to proceeding with the design incorporating any ECM motors, concurrence is required by the System Mechanical and Electrical Engineers.
10. Filter Racks - terminals shall contain a filter rack capable of holding a 1” thick filter. Filters shall be secured with quick release clips, allowing removal without horizontal sliding.
- Option - at the Consultant’s discretion, the terminal shall include a V- bank or similar design to ensure the filter velocity is below 600 feet per minute. Field fabricated racks are not acceptable.
11. Casing leakage rates shall be determined by design engineer.

**Design Criteria**  
**Division 23 – Heating, Ventilating and Air Conditioning**

## **General Information**

### **Automatic Temperature Controls**

Provide a temperature control/energy management system and control function for the entire building. The system shall include a standalone Direct Digital Control (DDC) System. This system shall communicate with the Central EMS at the Facilities Services Department through an Ethernet card and the campus instrumentation control distribution wiring system.

The EMS/Automatic Temperature Control (ATC) system must be compatible with the existing campus system. Systems or building components to be monitored and/or controlled by the central campus systems include, but are not limited to, the following: temperature control, temperature and humidity control of the greenhouse areas, fire alarm, security, outside building lighting, and the start and stop of major equipment. Monitoring of specific mechanical equipment and systems will be dependent on the recommendations of Facilities Department.

Provide metering of utilities with indication and totalization capabilities.

### **Energy Management System**

Provide a stand-alone direct digital control (DDC) system for space conditioning in campus buildings connected to the central campus EMS system. During the design development and construction documents phase, consult with the respective controls firm in order to determine the number of DDC Panels required and the location for each panel. The panel locations shall be shown on the detailed design drawings.

## **Campus Specific Information**

### **Texas A&M University**

Landis Division, Siemens Building Technologies, Inc.

### **Tarleton State University**

Johnson Controls, Inc.

### **Prairie View A&M University**

Johnson Controls, Inc.

**Texas A&M University at Galveston**

Landis Division, Siemens Building Technologies, Inc.

**Texas A&M University-Corpus Christi**

Landis Division, Siemens Building Technologies, Inc.

**Texas A&M International University**

Landis Division, Siemens Building Technologies, Inc.

**Texas A&M University-Kingsville**

Landis Division, Siemens Building Technologies, Inc.

**West Texas A&M University**

Johnson Controls, Inc. (Electronic, no pneumatics)

**Texas A&M University-Commerce**

TAC Americas, Inc.

**Texas A&M University-Texarkana**

South Campus and Main Campus  
Landis Division, Siemens Building Technologies, Inc.

**Baylor College of Dentistry**

TAC Americas, Inc.

On off campus locations and remote on campus locations, type of controls shall be as required in the Program of Requirements or as directed by FPC Project Manager. As a minimum these locations shall have a means for night, week-end and holiday set-back.

## Guide Specification

### Automatic Temperature Controls & Energy Management System

#### PART I General

- 1.1 The bidding and Construction Requirements and General Requirements apply to this work.
- 1.2 Furnish and install all temperature, pressure, and flow sensors, transmitters, relays, switches, wire, tubing, and conduit external to the DDC panels. Also furnish all pneumatic controls, operators, air supply with compressor, control valves, transducers and tubing to connect components. Submit for approval, appropriate product data cut-sheets for all material/components intended for use prior to beginning work.
- 1.3 Owner shall furnish Direct Digital Control (DDC) panels complete with all microprocessors, software, terminal strips, pneumatic transducers, relays, and regulated power supply with battery backup. Empty panel boxes will be furnished by the Owner for mounting by the Automatic Temperature Controls Contractor.
- 1.4 Owner shall furnish a Terminal Equipment Controller (TEC) and electronic inlet damper actuator(s) for installation on each VAV terminal box and fan coil unit by the box manufacturer. These DDC devices shall be delivered to the VAV box or fan coil unit manufacturer's factory in sufficient time for the manufacturer to meet their scheduled delivery obligations.
- 1.5 The box manufacturer shall provide for each box an inlet flow sensor(s) suitable for interfacing with a Honeywell micro bridge pressure transducer, any necessary pilot control relays, and factory mount and connect these devices and the DDC controller as required for proper operation as required under this section. The cost of factory mounting shall be included in the cost of the VAV boxes. All other wiring and terminations related to the DDC controller (TEC) shall be provided by the ATC contractor.
- 1.6 Room temperature sensors, room humidity sensors, and room sensor mounting base plates shall be provided by the Owner for installation by the ATC contractor.
- 1.7 Pneumatic temperature controls and non-DDC accessories that are standard catalog products as manufactured by Siemens Building

## Design Criteria Division 25 – Integrated Automation

Technologies, Inc., Johnson Controls, Inc., or Honeywell will be acceptable. Industrial instrumentation supplied shall be standard catalog products of Rosemount, Honeywell, Bristol, Foxboro, Leeds and Northrup, Taylor or Brown. All coordination and execution of work pertaining to the installation, service and guarantee, under this section of the specifications, shall be the sole responsibility of the Contractor.

- 1.8 All controls to be installed, calibrated and adjusted by trained instrument technicians in the full-time employ of the Automatic Temperature Controls Contractor. The ATC Contractor shall not subcontract this work in whole or in part to another contractor or individual(s).
- 1.9 The ATC Contractor shall be a factory-owned branch of the corporations listed in 1.10, below. Distributorships shall not be acceptable as ATC Contractors.
- 1.10 Acceptable ATC Contractors, provided they comply with these specifications, are:
  - a. Siemens Building Technologies, Inc.
  - b. Johnson Controls, Inc.
  - c. Honeywell, Inc.
  - d. TAC Americas, Inc.
- 1.11 Submit engineering/wiring drawings and receive approval prior to beginning work. These drawings shall be submitted in a timely manner to provide sufficient time to review drawings so as not to hold up the project.
- 1.12 The Owner-furnished DDC field panels will be located in mechanical rooms as shown on the drawings. All sensor and start/stop wiring will be brought back to the panel responsible for controlling/monitoring the mechanical/electrical equipment for which the sensor, start/stop wiring and tubing is directly related.
- 1.13 Division 26 shall provide power to a duplex receptacle inside each DDC panel. Power shall be provided from a breakered, 20 amp dedicated circuit having an insulated ground wire from the power panel ground buss wired to the duplex receptacle.
- 1.14 Furnish and install a network communications trunk (N.C.T.) between DDC panels, and a separate LAN communications network between each terminal unit controller (or group of controllers) back to the DDC panel associated with the AHU which serves the terminal units(2). Trunks shall be connected to the panels/controllers in a daisy-chain fashion, with no "T" connections permitted. In addition, the N.C.T. trunk shall be extended from the nearest Panel to an Owner-provided, dedicated line junction box.



**Design Criteria**  
**Division 25 – Integrated Automation**

- 1.15 The Owner shall provide the dedicated line between the junction box and the Campus Energy Management System, as well as program the panels with operational sequences and set-points specified.
- 1.16 Furnish, install and make connections of all interlock, power for sensors (if required), 24 volt, 40 va power source for each TEC, line and low-voltage wiring external to DDC panels. Wiring and tubing into panels shall require a minimum of 5 feet extra length with which the Owner will make final terminations inside the DDC panels. All wiring shall be clearly and permanently labeled as outlined in Section 1.17E below. Tubing will be labeled in a similar fashion as well.
- 1.17 Automatic Temperature Control/Engineering Management System wiring:
- A. All wiring and conduit shall be installed in accordance with related Specification Section Division 16 Electrical.
  - B. The conduit/wiring system required for the ATC/Energy Management System shall be a complete, separate, independent system. Conduit sharing with other unrelated electrical systems is not permitted. All control wiring shall be in conduit, 3/4 inch minimum.
  - C. Conduit fill limit shall not exceed 40 percent in any portion of the conduit system.
  - D. In order to facilitate maintenance, where multiple sensors or devices are connected to a common raceway or conduit, each sensor or device shall be individually connected to a common (non-sensor or device) junction box, which shall then be attached to the common conduit. Under no circumstances shall sensor or device wiring or tubing be routed through any other sensor or device's specific enclosure or junction box.
  - E. All wiring shall be labeled at both ends and at any spliced joint in between. Wire and tubing shall be tagged using 3M, ScotchCode WriteOn Wire Marker Tape Identification System; product number SWD-R-11954 with 3/4 inch x 5/16 inch write-on area or SLW 12177 with 1 inch x 3/4 inch write on area with 3M ScotchCode SMP Marking Pen. In addition to tagging at field device end and at spliced joints, a tag shall be placed 6 inches after entering each DDC panel. Identification and tag information shall be included in engineering/wiring submittal which must be submitted for Owner approval prior to beginning work. Tag information shall coincide with equipment/point information as written in the specification input/output summary.

**Design Criteria**  
**Division 25 – Integrated Automation**

- F. Digital Input (D.I.) wiring (Class 2) may be run in a common conduit with Digital Output (D.O.) wiring (Class 1) where local codes permit.
- G. Analog Input (A.I.), Analog Output (A.O.), Digital Input (D.I.), and Network Communications Trunk (N.C.T.) wiring may be run in a common conduit.
- H. Digital Output (D.O.) wiring run in a common conduit with Analog Input (A.I.), Analog Output (A.O.), or Network Communications Trunk (N.C.T.) is not permitted under any circumstances.
- I. AC line power to DDC panel shall be No. 12 THHN.
- J. Digital Output (D.O.) wiring shall be No. 14 THHN.
- K. Digital Input (D.I.), Analog Input 4-20 mA (A.I), and Analog Output (A.O.) wiring shall be No. 18 TSP (twisted, shielded pair with drain wire, stranded).
- L. Analog Input/Thermistor/or voltage types (A.I.) wiring shall be No. 18 TSP (twisted shielded pair with drain wire, stranded).
- M. Network Communications Trunk (N.C.T.) between DDC panels shall be two (2) individual No. 24 awg TSP (twisted, shielded pair, stranded) cables, not to exceed 12 pf capacitance per foot, wire-to-wire. Terminal Unit controller LAN networks shall be one (1) No. 24 awg TSP of the same type.
- N. Field devices requiring a 4-20 mA DC input signal shall be non-ground referenced.

1.18 System Verification--Procedure to be followed:

- A. Upon completion of all external sensor mounting, terminations, and wiring/air--piping into and out of the DDC panels, the Owner shall inspect and approved this work. The ATC Contractor shall make his Representative(s) available and coordinate with the Owner during this inspection process.
- B. Upon such approval being achieved, the Owner shall make terminations within the DDC panels.
- C. Following completion of the work and the Owner's DDC panel tie-in, a performance test shall be conducted by the Owner in the presence of the ATC Contractor. The ATC Contractor's representative shall be

## Design Criteria Division 25 – Integrated Automation

present at all times during the point-to-point checkout of the work, to quickly correct any wiring, tubing, and/or end device problems which may be uncovered during system startup.

D. Upon conclusion of final checkout and acceptance, the Contractor's responsibility reverts to warranty of materials and installation herein specified. System shall be warranted for a period of two (2) years.

1.19 Coordination of Effort: It is the responsibility of the Contractor to schedule and coordinate with the installer of owner furnished equipment. The ATC Contractor shall notify the Owner's DDC representative in writing when each panel or section of work is complete and ready for startup. Sufficient notice shall be given as described below. If any deficiencies are subsequently encountered by the Owner's DDC representative, the Owner's DDC representative, in order to expedite the progress of the project, may at his option, either correct the deficiency, or notify the ATC Contractor of the deficiency. Any costs incurred by the Owner's DDC representative due to having to correct any deficiency, or due to delays or multiple trips to the project site, shall be billed to the Owner, and forwarded to the ATC Contractor.

A. The Contractor shall schedule his construction activities so that all his work is verified and completed in due time to allow for the owner to install the DDC panels, make terminations, and prove the system. A minimum of 8 working days per panel shall be allowed in the project schedule for this purpose.

B. Coordination of activities is the responsibility of the Contractor. The Owners installer shall be notified a minimum of 7 days prior to the completion of Contractor work at the DDC box.

C. It is the Contractor's responsibility to schedule the accomplishment of these activities to allow for nominal system checkout, performance tests and balancing within the contract performance period.

1.20 Input/Output Summary: The following I/O Summary is provided as a summary of the minimum points required by this contract for connection to the Owner's Energy Management system. Furnish all devices, wiring, tubing, etc., necessary to serve and transmit to the Owner's panels. Any points not shown on the I/O Summary yet required to accomplish the sequence of operation shall be provided under this contract at no additional cost to the Owner.

*[A/E SHALL INCLUDE AN INPUT/OUTPUT SUMMARY FOR THE PROJECT. (SAMPLE ATTACHED). THE FOLLOWING SCHEDULE IS REPRESENTATIVE OF THE POINTS TO BE MONITORED AND CONTROLLED AND WILL BE USED AS A GUIDE FOR PREPARING*

*THE SUMMARY]*

A. Temperature Monitoring:

1. Outside Air.
2. Return Air.
3. Mixed Air.
4. Discharge Air Each Single Zone Unit.
5. Cold Deck Each Multizone Unit.
6. Hot Deck Each Multizone Unit.
7. Multizone unit--supply air temperature each zone.
8. Space Temperature of each Multizone Thermostat.
9. Chilled Water Supply and Return from Central Plant.
10. Hot Water Supply and Return from Central Plant.
11. Domestic Hot Water Supply from Central Plant.

B. Humidity Monitoring:

1. As required and as directed by Owner.

C. Start/Stop Functions (Differential Pressure):

1. Each Hot Water Pump.
2. Each Chilled Water Pump.
3. Each Air Handling Unit.
4. Each Domestic Hot Water Pump (as directed by owner).

D. Flow Monitoring (GPM):

1. Chilled Water Supply from Central Plant.
2. Hot Water Supply from Central Plant.
3. Domestic Hot Water Supply and return from Central Plant (as directed by owner).

E. Pressure Monitoring:

1. Duct Static Pressure of Each VAV System.
2. Chilled Water Supply and Return from Central Plant.
3. Heating Water Supply and Return from Central Plant.
4. Domestic Hot Water Supply from Central Plant (as directed by owner).
5. Differential Pressure across air filters (major units only).

F. Miscellaneous Monitoring:

1. Total Building Electrical (Volt, Amps, KW).

2. Electrical Usage (KW) of Each Motor (chilled water pumps, heat pumps, domestic hot water pumps, air handling unit (25 HP or larger)).

PART 2 Products

2.01 FIELD DEVICES

- A. Temperature Sensors: Platinum Resistance Temperature Detector, 0 degrees F to 400 degrees F range, 100 ohms at 0 degrees C, 316 stainless steel sheath, single element, 1/4 inch diameter sheath. For water sensing provide 316 stainless steel thermowells. Use 304 stainless steel extension fitting to extend assemblies through insulating materials. Spring-loaded sensors to ensure good surface contact in thermowells. Accuracy of + / - 0.1 degrees F from 20 degrees F to 70 degrees F for chilled water monitoring, accuracy of + / - 0.5 degrees F from 30 degrees F to 250 degrees F for condenser water, hot water, or domestic water monitoring, and accuracy of + / - 0.5 degrees F from 20 degrees F to 120 degrees F for all other temperature monitoring. Install on chilled water lines such that condensation does not collect in connection head. Duct temperature sensors shall be averaging type. Water sensors shall be provided with a separable stainless steel well. Outside air wall mounted sensors shall be provided with a sun shield. Accuracy of transmitter shall be unaffected by wiring distances up to 700 feet. Siemens Building Technologies, Inc., Minco, Hy-Cal only.
- B. Room Sensors:
  1. Each room temperature sensor shall come complete with a terminal jack and override switch integral to the sensor assembly. The terminal jack shall be used to connect the portable operator's terminal to control and monitor all hardware and software point associated with the terminal unit.
  2. An override switch will initiate override of the night setback or unoccupied mode to normal (day) operation when activated by the occupant. The switch function may be locked out, canceled or limited as to time or temperature in software by an authorized operator or a central or remote operator's terminal.
  3. Space temperature sensors may be Thermistor or 4-20 mA output RTD. The room sensor shall be firmly attached to the wall using approved construction techniques. Double-sided adhesive tape in lieu of screws is not acceptable.
  4. The room sensor shall be accurate to within + / - 0.5 degrees F (+ / -

## Design Criteria Division 25 – Integrated Automation

.3 degrees C) and have a set point adjustment range of 45 degrees to 85 degrees (5 degrees to 30 degrees C).

5. Room sensors shall be blank cover in all areas.
  6. Siemens Building Technologies, Inc., Minco, or Hy-Cal only.
- C. Flow Sensors: Flow sensors shall be constructed of stainless steel with no moving parts introduced into the flow medium. The sensor shall be a multiple tube, rigid structure that provides dual-averaging chambers with a diamond-shaped cross section. Each sensor shall be sized specifically for the pipe or elliptical in which it is to be installed, and shall be provide with individual flow calculation sheets stating so. Provide the proper instrument valve connections so that the differential pressure-sensing equipment can be removed while the system is pressurized. Instrument valve and tubing shall be stainless steel. Flow sensors shall be Dieterich Standard Annubar Model DMT PRESO or equal, installed in accordance with manufacturer's recommendations for an accuracy of + / - 1.05 percent of flow. Venturi or orifice flow sensing devices may be used for special applications.
- D. Temperature Transmitters: Temperature transmitters shall be designed for 4-20 mA DC output for Platinum RTD millivolt input sensor (as specified in Paragraph 2.1 above). Accuracy and range shall be the same as specified for the temperature sensors. Stability shall be + / - 0.2 percent of calibrated span for 6 months. Transmitter shall be a part of the temperature sensor assembly and shall be in a moisture-proof housing with a moisture-proof seal between the sensor and transmitter. Siemens Building Technologies, Inc., Minco, or Hy-Cal only.
- E. Water Flow Transmitters: Flow transmitters shall provide a 4-20 mA DC signal output proportional to flow. Accuracy of + / - 0.25 percent of calibrated span. Temperature Limits: -40 degrees F to +220 degrees F. Stability of + / 0.25 percent of upper range limit for 6 months. Range of transmitter shall be individually calibrated to match each flow meter's flow conditions, and shall be provided with individual flow calculation sheets stating so. Flow transmitters shall be Rosemont, Foxboro or Gould, only.
- F. Pressure Transmitters: Transmitters for water flow and pressure shall provide a 4-20 mA DC signal output directly proportional to pressure. Accuracy of + / - 0.5 percent of calibrated span. Span not over 200 percent of sensed pressure. Stability + / - 0.5 percent of upper range limit for 6 months. Stainless steel diaphragm, viton O-rings. Temperature limits: -20 degrees F to 220 degrees F. Rosemount, Setra,

or Bristol, only.

- G. Fan proof-of-flow switches shall be UL listed adjustable setpoint and differential pressure type. Switches shall be piped to fan discharge except where fans operate at less than one inch WG, they shall be piped across the fan. For fractional horse power and non-ducted fans, relays or auxiliary contacts may be used. Maximum pressure rating shall be at least 10 inches WC.
- H. Pump proof-of-flow switches shall be UL listed adjustable differential pressure or flow type as specified in the sequence of operation or data point summary. Devices shall be 150 psi rated except chilled water flow switches shall be provided with totally sealed vapor tight switch enclosure on 150 psi body. Differential pressure switches shall have valved manifold for servicing. Current monitor relays, properly sized for the associated load and having an adjustable switching set point, may be used in lieu of pressure switches on pumps; Hawkeye or equivalent.
- I. Air flow and static pressure analog transmitters shall be high accuracy suitable for the low velocity pressures to be encountered, be selected for approximately 50 percent over-range, and have an electronic 4 to 20 mA analog output. Transmitters shall have an accuracy of + / - 0.5 percent of calibrated span. These differential pressure sensors shall be connected to the air flow measuring station (where applicable) with valved lines for testing and calibration, and shall have adjustments for zero and span. Rosemount, Dresser Industries/Ashcroft XLDP or Setra C-264, only.
- J. Flow Switches shall be packless construction with all wetted parts made of brass and designed for mounting in pipe sensing wells. Device shall be capable of being mounted in pipe sensing wells 1 inch and larger. Paddle shall be provided with removable segments to accommodate required pipe size and flow. Switching action shall be single-pole, double-throw with a rating of 7.4 amps full load with 115 volts AC.
- K. Electric Low Limit Duct Thermostat: Snap-acting, two pole, single throw, manual reset switch which trips if temperature sensed across any 12 inches of bulb length is equal to or below set point, requiring minimum 15 feet length of bulb. Provide one thermostat for every 20 square feet of coil surface.
- L. Air Flow Measurement Station: Averaging "pitot" array per ASHRAE traversing guidelines, utilizing integral flow straighteners. Brandt Instruments B-DSK9000, Air Monitor FAN-E, or equivalent. The

AFMS shall have total static pressure sensors for sensing multiple velocity pressures in the air stream profile.

- M. Carbon Dioxide Sensor: CO<sub>2</sub> sensor shall be Horiba model number APBA-250E or approved equal. The unit shall be self contained for wall mounting application. The unit shall have a small pump for sampling point and fast response and shall have 0-1 percent range corresponding to an isolated 4-20 mA output. Visual alarm is not to be provided. The monitor shall utilize the non-dispersive infrared (NDIR) method.
- N. Humidity Sensor: Sensor shall provide a 0 to 100 percent range corresponding to an isolated 4 to 20 MA output. Accuracy of + / - 2 percent RH, with maximum drift of 1 percent per year.
- O. Static outside air probe shall be utilized where outdoor static pressures are to be measured. Provide a probe by Air Monitor, S. O. A. P., or approved equal. Probe shall be constructed of 10 gauge anodized aluminum with a 2 inch diameter FPT connection. The probe shall have a + / - 2 percent accuracy when subject to radial wind velocities of up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.
- P. Electric Room Thermostats: Provide line voltage room thermostats with cover. Set point must be adjustable from approximately 50 to 100 Deg. F. Minimum rating is 6 amps at 120 vac. Provide removable setting knob. Housings shall not contain thermometers.

**Q. TEMPERATURE CONTROL VALVES**

- 1. Valves shall be two way. Valves 2 inches and smaller shall have screwed bronze or brass bodies. Valves 2-1/2 inches or larger shall have flanged iron bodies. The assembled valves shall be rated for ANSI Class 125 operating pressure. All valves shall be sized for full flow and with a maximum pressure drop of 5 psi unless specified otherwise hereinafter. All straight through water valves shall have modified equal percentage flow characteristics. Valves shall close off against the full head of the system pumps.
- 2. Provide control valves with a chart indicating the valve constant (CV) rating of all valves referenced to the drawings so that the valve pressure drop may be used for balancing and performance tests.
- 3. Pneumatic valve operators shall have replaceable neoprene diaphragms, stainless steel stem, adjustable spring, replaceable EPT disk, shall be spring loaded, self adjusting packing. Actuator shall have metal housing. Operating temperature range shall be 25



to 300 degree F. Valves which are used in sequence with another on the same pneumatic signal shall be provided with positive positioners.

**R. BUTTERFLY VALVE ACTUATORS**

1. Butterfly valves shall be straight-through type, as described elsewhere. Operators shall be capable of receiving 60-80 psi air signal for on/off service and for modulating service shall be equipped with a positioner capable of receiving 3-15 psi air signal and transmitting 60-80 psi signal to operator. Valves shall be suitable for 150 psi bubble tight shut-off. Valve construction shall be as specified elsewhere. Valves shall be available with field interchangeable powered actuators. The actuator-to-shaft connection shall be designed to shear and prevent internal valve damage if the disc closes on foreign material in the pipeline. All actuators shall provide external indication of disc position.
2. All units to have adjustable open and close position stops with provision to prevent accidental changes. Operating shaft to be supported axially and radially at input end by permanently lubricated bronze thrust and sleeve bearings.
3. Cylinder actuators shall have gear actuator in weatherproof enclosure with integral double-acting pneumatic cylinder sized for maximum differential of 150 psi working mechanism fully enclosed, and shall be sized for operations using 80 psi pneumatic supply. Cylinder actuators to be furnished with pilot valves, Bailey-type positioners, limit switches, manual override, speed control valves. All units shall have adjustable open position stops. Damper-motor-type actuators shall not be acceptable for butterfly valve actuation.

**S. PNEUMATIC DAMPER ACTUATORS**

Pneumatic damper actuators shall be of the piston type equal to Landis and Staefa AP 331 Series actuator. Actuators of plastic will not be acceptable.

**T. AIR FLOW CONTROL DAMPERS**

1. The Temperature Control Contractor shall provide all control dampers of the type indicated on the plans. Frames shall not be less than 13 gauge galvanized steel. Blades must not be over 8 inches wide nor less than 16 gauge galvanized steel roll formed. Bearings shall be oilite, ball bearing or nylon with 1/2 inch shafts. Side seals shall be stainless steel of the tight-seal spring type.

Dampers and seals shall be suitable for temperature ranges of -40 degrees F to 200 degrees F.

2. All proportional (modulating) control dampers shall be opposed blade type and all two-position dampers shall be parallel-blade types.
3. Dampers shall be minimum leakage type to conserve energy and the manufacturer shall submit leakage and flow characteristic data for all control dampers with the temperature control submitted. Maximum leakage shall be 3 percent at static pressure of 3 inches of WC.

#### U. CONTROL AIR SUPPLY

1. Provide two air compressors each sized for maximum running time of 33 percent at 80 psi with automatic alternator for temperature control usage, and one compressed air drier.

Both compressors shall be mounted on a single storage tank of sufficient size to insure not more than six compressor operations per hour. Tank shall conform to the ASME Code for non-fired pressure vessels and so stamped. Each compressor shall be equipped with a pressure intake filter, outlet filter, belt guards and automatic trap and drain for each tank. The compressor motors shall be suitable for operation on 460 AC, 3-phase, 60 Hertz. Furnish an Allen-Bradley, or approved equal, automatic electric alternator for the units which will operate first one compressor and then the other, but will operate both compressors in the event air pressure fall too low. Provide override switch to omit alternator and allow either compressor to operate individually in the event one compressor is inoperable. Control voltage shall be 120 volts AC.

2. Compressed Air Drier shall be Ingersoll-Rand, Zeks, or approved equal, refrigerated moisture condenser. The air piping from each compressor duplex unit shall be so piped that air from either compressor will pass through the drier. The moisture condenser shall come with a wall bracket and automatic trap. The condenser shall be sized to maintain a 10 degree F dewpoint of the air supply to the system.
3. Main Air Pressure Reducing Stations: Provide a combination sub-micron filter-pressure reducing station. The filter shall be capable of the removal of entrained oil and shall be rated for 97 percent efficiency at rated air flow. Air reducing valve shall be sized for quantity of air required and be capable of reducing air supply form

60 psi to control air pressure. The entire air supply at the air compressor shall be piped in parallel to permit shut down of a compressor without feedback in any part of the system which has been shut down. Provide high pressure main air to each DDC panel location, with PRV to serve DDC pneumatic transducers (one PRV per DDC panel location). Provide 2 inch diameter air pressure gauges upstream and downstream of reducing station.

#### V. PNEUMATIC INSTALLATION

The pneumatic portion of the temperature control system shall be installed by men regularly employed by the ATC Contractor. User of subcontractors by the ATC Contractor shall be unacceptable. Pneumatic piping shall be concealed wherever practical. Hard-drawn copper tubing or poly encased in raceway is to be used for all areas. Copper tubing shall be installed in neat and workmanlike manner and shall be as inconspicuous as possible. Bulkhead fittings shall be utilized for all penetrations through enclosures, raceways, and the like. Poly tubing, where employed as flexible connections within hard copper runs, shall be limited in length to 6 inches. The entire system shall be tested under applicable operating air pressure for a period of twenty-four (24) hours during which the pressure drop shall not exceed 2 psig.

### PART 3 Execution

#### 2.01 SEQUENCE OF OPERATION

*[A/E TO INCLUDE CONTROL SEQUENCE OF OPERATION]*

Refer to the I/O Summary for any additional points required.

## Guide Specification for TAMU Projects

### Automatic Temperature Controls & Energy Management System

#### PART I General

- A. The bidding and Contract Requirements and General Requirements apply to this work.
- B. Furnish and install all components but not limited to all temperature, pressure and flow sensors, transmitters, relays, switches, wire and conduit external to the DDC panels. Also furnish all controls, operators, power supplies, control valves, air and water flow measuring stations, transducers and wiring to connect components. Submit for approval, appropriate product data cut sheets for all material/components intended for use prior to beginning work. Where EMS is used in specification and drawings, it is understood to be same as DDC. In addition, provide a complete installation of the owner furnished Siemens DDC System. In addition, install the owner furnished Siemens Laboratory Control System (LCS).
- C. Owner shall furnish all Siemens Direct Digital Control (DDC) panels with all microprocessors, software, terminal strips, transducers, relays, and regulated power supply with battery backup. Empty panel boxes will be furnished by the Owner for mounting by the Automatic Temperature Controls Subcontractor.
- D. Owner shall furnish a Siemens HVAC Terminal Equipment Controller (TEC), electronic damper actuator(s), and electronic HW valve's and actuator's for installation on each VAV terminal unit and fan coil unit, as applicable, by the terminal equipment manufacturer. These DDC devices shall be delivered to the manufacturer's factory in sufficient time for the equipment manufacturer to meet their scheduled delivery obligations. Owner shall furnish all Siemens DDC lab control system components, including TECs, Lab Supply Air Terminal Units with reheat coils (duct mounted), General Air Fume Hood Exhaust Terminals, and all other associated controls components. Installation of all air terminals shall be by the mechanical contractor.
- E. The terminal equipment manufacturer shall provide for each VAV box an inlet flow sensor suitable for interfacing with the Siemens TEC. For VAV boxes and all other terminal equipment (fan coil units, etc.) a 24 vac, 40 va transformer, any necessary pilot control relays will be provided by the ATC, and installed by the ATC, and connect these devices to the DDC controller as required for proper operation as required under this section. The cost of factory mounting shall be included in the cost of the terminal equipment. All other wiring and terminations related to the DDC controller (TEC) shall be provided by the ATC contractor. All other wiring and terminations related to the lab control system components shall be provided by the ATC contractor.

**Design Criteria**  
**Division 25 – Integrated Automation**

- G. The ATC Contractor shall provide for each TEC, a 24 vac 40 va power source, and mount and connect these devices and the DDC controller as required for proper operation as required under this section. All other wiring and terminations related to the TEC shall be provided by the ATC contractor.
- H. Room temperature sensors, CO<sub>2</sub> sensors, and sensor and humidity mounting plates shall be provided by the Owner for Installation by the ATC contractor. Terminal Unit Control Valves provided by Owner will be installed by Mechanical Contractor. Humidity sensors provided by Owner will be installed by ATC Contractor.
- I. Temperature controls and non-DDC accessories that are standard catalog products as manufactured by Siemens Building Technologies, Inc., Johnson Controls, Inc., or Honeywell will be acceptable. Industrial instrumentation supplied shall be standard catalog products of Rosemount, Honeywell, Bristol, Foxboro, Leeds and Northrup, Taylor or Brown. All coordination and execution of work pertaining to the installation, service, and guarantee, under this section of the specifications, shall be the sole responsibility of the ATC.
- J. All controls to be installed, calibrated and adjusted by trained instrument technicians in the full-time employ of the Automatic Temperature Controls Subcontractor.
- K. Mechanical contractor shall not serve as ATC contractor. Acceptable ATC contractors, provided they comply with these specifications are:
  - 1. Siemens Building Technologies, Inc.
  - 2. Johnson Controls, Inc.
  - 3. TAC Control Systems.
  - 4. No exceptions
- L. Submit engineering/wiring drawings receive approval prior to beginning work. These drawings shall be submitted in a timely manner provide sufficient time to review drawings so as not to hold up the project.
- M. The Owner-furnished DDC field panels will be located in mechanical rooms as shown on the drawings. All sensor and start/stop wiring will be brought back to the panel responsible for controlling / monitoring the mechanical / electrical equipment for which the sensor, start/stop wiring is directly related. The location of the panels may not be shown on the drawings. Locate Laboratory Control Panels as indicated on drawings.
- N. Division 26 shall provide emergency power to a duplex receptacle inside each panel. Emergency power shall be provided from a breakered, 20 amp dedicated circuit having an insulated ground wire from the power panel ground buss wired

to the duplex receptacle.

- O. Furnish and install a dedicated Ethernet cabling network for the DDC system, all exposed wiring shall be in conduit, as per division 26 specifications. Concealed wiring shall be plenum rated. All active Ethernet switches, hubs, and routers shall be Owner-provided and installed (by Siemens).

Furnish, install and terminate individual Cat-6 cable assemblies to interconnect each mechanical room in a star configuration. A star configuration is designed with each main building panel connected directly to a network switch. Data is passed through the switch before continuing to its destination to other main building panels and to the front end. Each cable shall originate and terminate within one designated DDC panel in each mechanical room, as shown on the plans. Additionally, furnish, install and terminate individual Cat-6 cable assemblies to connect each DDC panel within the mechanical room(s) with the others in that same room, in a star configuration.

Each cable assembly shall originate and terminate within the DDC panel enclosure(s), with 5 feet of extra length at each end, so that no spicing, jumpers or extensions are required to complete the network between panels. Each cable shall be clearly labeled, identifying the DDC panel of origin, and the DDC panel to which it is to be connected.

All cable runs between mechanical rooms and/or DDC panels shall be no longer than allowed as specified in section 16700. Where runs are required that will be longer than section 27 allow, furnish and install an additional enclosure near the midpoint (coordinate location with architect), to be used as a network junction box, complete with a 120 VAC emergency power source. Terminate and label the cables within this junction box as directed for each DDC panel.

Refer to section 27 specifications for complete network cable specifications. Furnish and install a network communications trunk (N.C.T.) between DDC panels, and a separate LAN communications network between each terminal equipment controller (or group of controllers) back to the DDC panel associated with the AHU which serves the terminal unit (or lab-trac system). Trunks shall be connected to the panels/controllers in a daisy-chain fashion, with no “T” connections permitted. A maximum of 32 TECs per LAN trunk shall be permitted.

- P. Furnish, install and make connections of all Interlock, power for sensors (if required), line and low-voltage wiring external to DDC panels. Wiring into panels shall require a minimum of 5 feet extra length which the Owner will make final terminations inside the DDC panels. All wiring shall be clearly and permanently labeled as outlined below.
- Q. The ATC Contractor shall provide a dedicated line between the junction box and the Campus (University) Energy Management System, as well as program the

panels with operational sequences and set-points specified.

**1.02 SUBMITTALS:**

- A. Manufacturer's Product Data: All equipment components
- B. Shop Drawings:
  - 1. System wiring diagrams with sequence of operation for each system as specified.
  - 2. Submit manufacturer's product information on all hardware items along with descriptive literature for all software programs to show compliance with specifications.
  - 3. System configuration diagram showing all panel types and locations as well as communication network and workstations.

**1.03 AUTOMATIC TEMPERATURE CONTROL / ENGINEERING MANAGEMENT SYSTEM WIRING:**

- A. All wiring and conduit shall be installed in accordance with related Specification Section Division 26 Electrical.
- B. The conduit / wiring system required for the ATC/Energy specification Input/Out summary.
- C. Digital Input (D.I.) wiring (Class 2) may be run in a common conduit with Digital Output (D.O.) wiring (Class1) where local codes permit.
- D. Analog Input (A.I.), Analog Output (A.O.), Digital Input (D.I.), and Network Communications Trunk (N.C.T.) wiring may be run in a common conduit.
- E. Digital Output (D.O.) wiring run in a common conduit with Analog Input (A.I.), Analog Output (A.O.), is not permitted under any circumstances.
- F. AC line power to DDC panel shall be #12 THHN.
- G. Digital Output (D.O.) wiring shall be #14 THHN.
- H. Digital Input (D.I.), Analog Input 4-20 mA (A.I.), Analog Output (A.O.) wiring shall be #20 TSP (twisted shielded stranded pair with drain wire).
- I. Analog Input/Thermistor/or voltage types (A.I.) wiring shall be #20 TSP (twisted shielded stranded pair with drain wire).
- J. Field devices requiring 4-20 mA DC input signal shall be non-ground referenced.

**1.04 SYSTEM VERIFICATION—PROCEDURE TO BE FOLLOWED:**

- A. Provide minimum 2 week written notice for all inspections.
  - B. The system verification also includes the Laboratory Control System.
  - C. Upon completion of all external sensor mounting, terminations, and wiring into and out of the DDC panels, the Owner shall inspect and approve this work. The ATC Subcontractor shall make his Representative(s) available and coordinate with the Owner during this inspection process. At the successful conclusion of this inspection, contractor shall provide a written report stating all work is complete. ATC Subcontractor, General Contractor and Owner's Rep shall sign. This should be filed with Project Commissioning/Startup documents.
  - D. Upon such approval being achieved, the Owners representative shall make terminations within the DDC panels.
  - E. Following completion of the work and the Owner's DDC panel tie-in, a performance test shall be conducted by the Owner in the presence of the Contractor and his appropriate Subcontractors.
  - F. The ATC shall be present for the testing of proper operation of each and every physical system point to which the ATC has provided devices, wiring, in order to verify the equipment and installation provided by them (their portion of the work), i.e., when the Owners representative commands a point, the ATC verifies in the field that the commanded point operates properly. At the successful conclusion of this inspection, contractor shall provide a written report stating all work is complete, calibrated and functioning property per the specified sequences of operation. ATC Subcontractor, General Contractor and Owner's Rep shall sign. This should be filed with Project Commissioning/Startup documents.
  - G. Owner's representatives shall attend initial inspection and verification of completed punch list of items in paragraphs C. and F. of this section. Further inspections required due to incomplete/incorrect work shall be at ATC expense.
  - H. Upon conclusion of final checkout and acceptance, the ATC responsibility reverts to warranty of materials and installation herein specified. System shall be warranted for a period of two (2) years.
- 1.05 COORDINATION OF EFFORT:
- A. It is the responsibility of the ATC to schedule and coordinate with the installer of owner furnished equipment.
  - B. The ATC shall schedule his construction activities so that all his work is verified and completed in due time to allow for the Owners representative to install electronic components in the DDC panels, make terminations, and prove the



system. A minimum of 8 working days per panel shall be allowed in the project schedule for this purpose.

- C. Coordination of activities is the responsibility of the ATC. The Owners installer shall be notified a minimum of 7 days prior to the completion of the ATC work at the DDC can.
- D. It is the ATC responsibility to schedule the accomplishment of these activities to allow for nominal system checkout, performance tests and balancing within the contract performance period.

The ATC shall notify the Owners representative in writing when each panel or section of work is complete and ready for startup, meaning that fans are ready to run, VFD's have been started up, CHW is available, all devices are functional, power is on to all devices and panels, etc.

Sufficient notice shall be given as described above.

- E. If any deficiencies are subsequently encountered by the Owners representative in work identified in writing by the ATC as complete and ready for startup, in order to expedite the progress of the project, the Owners representative may, at their option, either correct the deficiency, or notify the ATC of the deficiency and have them correct it. Any costs incurred by the Owners representative due to having to correct any deficiency, or due to delays or multiple trips to the project site, shall be billed to the ATC.

## **Metering**

All projects shall have all utilities metered and remotely monitored by Utilities and Energy Management. The metering shall be accomplished by the following:

1. The electrical contractor shall furnish and install at least one (1) Square D 'Powerlogic' model #3250 electric meter at the electrical service entrance for each building that will read the entire building electrical load. Double ended substations or additional services entrances shall require an additional model #3250 meter.
2. The electrical contractor shall furnish and install additional Square D meters as required for sub-metering electric loads as required to meet LEED verification requirements. These meters can be "Power Meters", "Intercept Meters" or similar four wire digital meters manufactured by Square D that can be networked with the main "PowerLogic" meter(s). If auxiliary enterprise areas are included in the building, those areas shall have the electrical load isolated and measured by a revenue quality Square D four wire digital meter. All meters shall have a local display.
3. The electrical contractor shall provide and install all interconnect wiring to all meters regardless of their location. All wiring shall meet Square D standards for type,

length, installation and connection.

4. The electrical contractor shall furnish and install an EGX-400 internet interface module mounted in its own enclosure mounted on a wall inside the main electrical room. This module shall be connected to emergency power (if a generator is included in the design) and to a category 6 data connection served from the nearest data/telecom room.

5. The electrical contractor shall furnish and install a Square D “WAGES” (Water, Air, Gas, Electric, Steam) box that is to be mounted in the building pump room. All inputs listed in the points list related to metering a utility (except electric) shall be routed to the WAGES box by the ATC using appropriate cables and left labeled but unterminated. The ATC shall also install an additional set of cables from the WAGES box to the Siemens main DDC enclosure for termination.

6. Prior to energizing the main electric switchgear the contractor shall schedule and pay a Square D technician to commission the main electric meter(s) and all other meters located in the main switchgear. This commissioning will include a complete setup of the meter(s), termination of all meter interconnecting cables located in the main switchgear, entering all required security codes and flags as directed by the Utilities and Energy Management and verification that the meter(s) are reading correctly.

7. Prior to any Substantial Completion the contractor must arrange and pay for a second commissioning trip from Square D to complete all connections to the Square D meters, all connections to the WAGES box and verify proper operation of both systems. This verification shall include the modification of the head end equipment located at the Energy Office. Data connections must be installed and functional so that Square D can verify the communication between the project meters and the Energy Office. This commissioning may require multiple days and multiple trips from Square D.

## General Information

This Division provides general information and standard design criteria for the typical *medium-voltage* and *low-voltage* electrical distribution systems presently serving most of the A&M System Member campuses, including those campuses that are in relatively early stages of development.

*Note: The terms “medium-voltage” and “low-voltage” refer to the following voltage classes as defined in IEEE 141, Chapter 3: Medium-voltage includes the class of nominal system voltages equal to or greater than 1000V but less than 100,000V. Low-voltage encompasses the class of nominal system voltages less than 1000V.*

## Purpose & Application of this Division

NFPA 70, the *National Electrical Code*<sup>®</sup> (NEC<sup>®</sup>) essentially contains provisions considered necessary to *safety*. As explained in Article 90.1(B), compliance with the applicable codes and proper maintenance of systems will result in installations that are “free from hazard but [are] not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.” The purpose of this division of the Facility Design Guidelines (FDG) is to provide site-specific design criteria and guidance to ensure that electrical system installations are free from hazard; are standardized, efficient, reliable, convenient, maintainable, sustainable, and adaptable for future use; and will provide quality service over the expected life of the building(s) or facility(ies) served.

Electrical design, material, equipment, and installations shall comply with site-specific requirements of this division and the project-specific requirements identified in the “Program of Requirements” (POR). Where appropriate, guidance is provided to encourage the cost-effective implementation of site-specific requirements and certain laws and regulations mandated by federal, state, and local code agencies.

In addition to new electrical installations, the criteria of this division apply to all renovation, replacement, modification, maintenance, and rehabilitation projects for which the *Texas Engineering Practice Act* and the Authority Having Jurisdiction (AHJ) requires an electrical design.

## Electrical Codes & Standards

### Overview

Electrical design, material, equipment, and installation shall comply with the applicable portions of the latest edition of each code and standard listed below or referenced elsewhere in this chapter, in effect at the time of design contract award, unless otherwise noted in the contract.

*Note: If a later edition of a code or standard is adopted by the State during the course of project design or construction it shall be the Owner's option to require that those revisions be met before project acceptance.*

In many instances, recommendations or “best practices” presented in building codes, electrical codes, and industry standards have been adopted as standard requirements in this division of the FDG.

If there is a conflict between codes or standards and FDG requirements in this division, contact the FPC System Electrical Engineer for assistance in resolving the conflict. If a requirement in the FDG exceeds a minimum code or standard requirement, it is not considered a conflict but a difference.

Where the *NEC*<sup>®</sup> uses terms similar to “by special permission,” obtain written permission from the FPC System Electrical Engineer.

#### **Codes & Standards Applicable to this Division**

ANSI – American National Standards Institute:

- ANSI Z535.1, Safety Colors
- ANSI Z535.2, Environmental and Facility Safety Signs
- ANSI Z535.3, Criteria for Safety Symbols
- ANSI Z535.4, Product Safety Signs and Labels

ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers:

- ASHRAE Standard 90.1, *Energy Standards for Buildings Except for Low Rise Residential Buildings* [ANSI, IESNA]\*

ASTM – American Society for Testing and Materials

CBM – Certified Ballast Manufacturers

ICC – International Code Council

- International Building Code<sup>®</sup> (IBC)
- International Existing Building Code<sup>®</sup> (IEBC)

ICEA – Insulated Cable Engineers Association

- ICEA S-93-639, *Shielded Power Cables 5-46kV* (NEMA WC-74)

IEEE<sup>®</sup> – Institute of Electronics and Electrical Engineers:

- IEEE C2™, *National Electrical Safety Code (NESC)* [ANSI]
- IEEE Std 141™, *Recommended Practice for Electric Power Distribution for Industrial Plants* (“Red Book”)
- IEEE Std 142™, *Recommended Practice for Grounding of Industrial and Commercial Power Systems* (“Green Book”)
- IEEE Std 241™, *Recommended Practice for Electric Power Systems in Commercial Buildings* (“Gray Book”)
- IEEE Std 242™, *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems* (“Buff Book”)
- IEEE Std 315™, *Graphic Symbols for Electrical and Electronics Diagrams*
- IEEE Std 399™, *Recommended Practice for Power Systems Analysis* (“Brown Book”)
- IEEE Std 446™, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications* (“Orange Book”)
- IEEE Std 493™, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems* (“Gold Book”)
- IEEE Std 519™, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*
- IEEE Std 739™, *Recommended Practice for Energy Management in Industrial and Commercial Facilities* (“Bronze Book”).
- IEEE Std 902™, *Guide for Maintenance, Operation, and Safety of Industrial and Commercial Power Systems* (“Yellow Book”)
- IEEE Std 1015™, *Recommended Practice Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems* (“Blue Book”)
- IEEE Std 1100™, *Recommended Practice for Powering and Grounding Electronic Equipment* (“Emerald Book”)
- IEEE Std 1584™, *Guide for Performing Arc-Flash Hazard Calculations*

IESNA – Illuminating Engineering Society of North America:

- IESNA *Lighting Handbook*, Ninth Edition
- IESNA RP-1, *American National Standard Practice for Office Lighting*
- IESNA RP-7, *American National Standard Practice for Lighting Industrial Facilities*

NECA – National Electrical Contractors Association:

- NECA 1, *Good Workmanship in Electrical Construction* [ANSI]
- NECA 90, *Recommended Practice for Commissioning Building Electrical Systems* [ANSI]
- NECA 100, *Symbols for Electrical Construction Drawings* [ANSI]
- NECA 101, *Standard for Installing Steel Conduits (Rigid, IMC, EMT)* [ANSI]
- NECA 104, *Recommended Practice for Installing Aluminum Building Wire and Cable* [ANSI]
- NECA / NEMA 105, *Recommended Practice for Installing Metal Cable Tray Systems* [ANSI]
- NECA 111, *Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)*

- [ANSI]
- NECA / NACNA 120, *Standard for Installing Armored Cable (Type AC) and Metal-Clad Cable (Type MC)* [ANSI]
  - NECA 202, *Recommended Practice for Installing and Maintaining Industrial Heat Tracing Systems* [ANSI]
  - NECA 230, *Standard for Selecting, Installing and Maintaining Electric Motors and Motor Controllers* [ANSI]
  - NECA 331, *Standard for Building and Service Entrance Grounding and Bonding*
  - NECA 400, *Standard for Installing and Maintaining Switchboards* [ANSI]
  - NECA 402, *Standard for Installing and Maintaining Motor Control Centers* [ANSI]
  - NECA / EGSA 404, *Standard for Installing Generator Sets* [ANSI]
  - NECA 407, *Recommended Practice for Installing and Maintaining Panelboards* [ANSI]
  - NECA 408, *Recommended Practice for Installing and Maintaining Busways* [ANSI]
  - NECA 409, *Recommended Practice for Installing and Maintaining Dry-Type Transformers* [ANSI]
  - NECA 410, *Recommended Practice for Installing and Maintaining Liquid-Filled Transformers* [ANSI]
  - NECA 411, *Recommended Practice for Installing and Maintaining Uninterruptible Power Supplies (UPS)* [ANSI]
  - NECA 420, *Standard for Fuse Applications* [ANSI]
  - NECA 430, *Standard for Installing Medium-Voltage Metal-Clad Switchgear* [ANSI]
  - NECA / IESNA 500, *Recommended Practice for Installing Indoor Lighting Systems* [ANSI]
  - NECA / IESNA 501, *Recommended Practice for Installing Exterior Lighting Systems* [ANSI]
  - NECA / IESNA 502, *Recommended Practice for Installing Industrial Lighting Systems* [ANSI]
  - NECA / MACSCB 600, *Recommended Practice for Installing and Maintaining Medium-Voltage Cable* [ANSI]
  - NECA / NEMA 605, *Installing Underground Nonmetallic Utility Duct* [ANSI]

NEMA – National Electrical Manufacturers Association

NETA – International Electrical Testing Association, Inc.:

- NETA ATS, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*
- NETA MTS, *Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*
- NETA ETT, *Standard for Certification of Electrical Testing Technicians* [ANSI]

NFPA – National Fire Protection Association:

- NFPA 20<sup>®</sup>, *Standard for the Installation of Stationary Pumps for Fire Protection*<sup>®</sup>

- NFPA 70™, *National Electrical Code® (NEC®)*
- NFPA 70E, *Standard for Electrical Safety in the Workplace*
- NFPA 101®, *Life Safety Code®*
- NFPA 110, *Standard for Emergency and Standby Power Systems*
- NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*
- NFPA 780, *Standard for the Installation of Lightning Protection Systems*
- All other NFPA codes and standards except NFPA 5000

OSHA – Occupational Safety and Health Administration

IECC – International Energy Conservation Code

ISO – International Organization for Standardization

Texas State Energy Conservation Code

Applicable county and municipal codes

*\*Note: Codes and standards that have been adopted by other publishers are indentified by their acronym in a [bracket] at the end of the listing above.*

## Fundamental System Requirements

### Adequacy & Future Expansion

Provide electrical systems with adequate capacity for the initial known requirements plus provisions for future expansion of the system as follows:

- For new facilities with an expected facility service life of 30 years or more, design for a future load growth (FLG) of 1% over of the initial design load per year of expected facility service life, but not exceeding 30%. *Refer to IEEE Std. 141-1993, paragraph 2.4.1.4.*
- For new facilities with less than 20 years of expected service life, an FLG of less than 20% may be assumed for design purposes.
- For service renovations to existing facilities, design electrical systems with the FLG based on 1% per year of expected remaining service life of the renovated facility.

### Fault Current Capacity

Provide electrical equipment with bus bracing and device interrupting capacities that exceed the fault current available at the terminals.

### Facility Lightning Protection

Provide systems protected from the effects of direct or nearby lightning discharges in accordance with NFPA 780, IEEE Std 1100, and the IEEE C62, *Surge Protection Standards Collection*.

### Power Quality

Design power systems in accordance with the recommended design practices in IEEE Std 1100™ and IEEE Std 141™ related to power quality.

In addition, provide electrical systems that are selected and configured to provide adequate power quality for the satisfactory operation of electrical utilization equipment according to the following guidance:

- Specify the highest practical service, distribution, and utilization voltages appropriate for the load(s) served.
- Serve “high-impact” electrical loads such as HVAC equipment, elevators, and process loads from different feeder sources that serve sensitive loads such as electronic equipment, computers, and instrumentation.
- Locate step-down transformers and the associated panelboards as physically close as practicable to the loads served by that equipment. *This rule applies to the utility medium-voltage transformer(s) serving the building as well as the low-voltage transformers supplying smaller loads distributed throughout the building.*
- Balance the loads on each low-voltage feeder so that the voltage on each phase is within +/- 1.0% of the *average* voltage of the three phases. *Refer to the DOE Office of Industrial Technologies, “Motor Tip Sheet #7” dated September 2005 available for download to PDF format at no charge at: [http://www1.eere.energy.gov/industry/bestpractices/pdfs/eliminate\\_voltage\\_unbalanced\\_motor\\_systems7.pdf](http://www1.eere.energy.gov/industry/bestpractices/pdfs/eliminate_voltage_unbalanced_motor_systems7.pdf).*

### Power System Harmonic Limits

Limit harmonic currents at the point of service for each building to comply with IEEE Std 519™. *IEEE Std. 141-1993™, Chapter 9 refers to IEEE Std 519™ for limits on the harmonic currents that a user can induce back into the utility power system.*

### Power System Reliability

Design power systems in compliance with IEEE 493™ to ensure that systems and equipment deemed to be essential to life safety and critical to facility operations are supplied with power at a high degree of reliability and continuity.



*IEEE 493™ provides proven methods of quantitative reliability analysis as it applies to the practical planning and design of cost-effective electric power distribution systems.*

Consider the need for multiple transformer-switchgear service equipment to ensure power supply continuity within the facility during scheduled or emergency equipment outages.

### **Overcurrent Protection**

Provide fully selectively coordinated overcurrent protection.

If ground-fault protection is required for the service or feeder disconnecting means in accordance with the *NEC*®, extend ground-fault protection for the feeders and/or branch-circuits originating from the main service equipment bus immediately downstream of the service disconnecting means.

### **Standards for Material & Equipment**

Use electrical materials and equipment that is constructed and tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized commercial standard.

If material and equipment is labeled, listed, or recognized by any Nationally-Recognized Testing Laboratory (NRTL) acceptable to the Occupational Safety and Health Administration (OSHA) and the TAMUS AHJ, then provide NRTL-labeled, -listed, or -recognized material and equipment. Acceptable NRTLs include but are not limited to:

- Underwriters Laboratories, Inc. (UL)
- Factory Mutual Research Corp. (FMRC) (also referred to as “Factory Mutual Global,” or “FM Global”)
- Intertek Testing Services NA, Inc. (ITSNA, formerly ETL)
- Canadian Standards Association (CSA)

A complete listing of **acceptable** NRTLs is published on the OSHA website at <http://www.osha.gov/dts/otpca/nrtl/>.

Where material and equipment is not labeled, listed, or recognized by any NRTL, provide a manufacturer’s Certificate of Compliance indicating complete compliance of each item with applicable standards of NEMA, ANSI, ASTM, or other recognized commercial standard.

Do not install or use electrical material or equipment for any use other than that for which it was designed, labeled, listed, or identified unless formally approved for such use by the TAMUS AHJ. This *National Electrical Code*® requirement is re-stated for emphasis.

## Personnel Safety

Design systems and select equipment to minimize or eliminate the risks of electrocution, arc-flash, and arc-blast hazards to maintenance and operations personnel. *Refer to NFPA 70E, Article 130.1.*

*Equipment and design practices are available to minimize energy levels and the number of at-risk procedures that require an employee to be exposed to high energy level electrical sources. Proven designs to reduce the hazards of electrical systems include:*

- *Arc-resistant switchgear, motor control centers, and other compartmentalized equipment.*
- *Remote racking systems for the installation and removal of large/heavy circuit breakers.*
- *Remote opening and closing of switching devices.*
- *Higher impedance transformers and current-limiting reactors.*
- *Insulated or isolated busses in switchboards and switchgear assemblies.*

## Locating Electrical Equipment

Locate electrical equipment so it will be accessible for inspection, service, repair, and replacement without removing permanent construction, with working clearance and dedicated space as required by the *NEC*<sup>®</sup> and as recommended by the manufacturer.

Locate equipment so generator exhaust does not enter occupied spaces through outside air intakes.

## Identifying Electrical Equipment

### Overview

Provide the following types of identification on all electrical equipment as required by TAMUS standards, the *NEC*<sup>®</sup>, and NFPA 70E:

- Arc-flash and shock hazard-warning labels
- Component identification
- Equipment nameplates
- Diagrams and Operating Instructions
- Emergency System Equipment Identification
- Warning Signs, Markers, & Device Labels

### Arc-Flash & Shock-Hazard Warning Labels

Install arc-flash and shock hazard-warning labels that comply with ANSI Z535.4 on switchgear, switchboards, transformers, motor control centers, panelboards, motor controllers, safety switches, industrial control panels, and other electrical equipment

that is likely to require examination, adjustment, servicing, or maintenance while energized.

Locate the marking to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

*Note: Refer to Section 110.16 in the NEC®.*

On renovation projects, install arc-flash warning labels on existing equipment where lock-out/tag-out will be required for the renovation work.

*Note: Refer to NFPA 70-E, Articles 120 and 130.*

Provide the information listed below on each label. Specify that arc-flash warning label information be produced by the electrical equipment manufacturer or supplier as a part of the final power system studies to be submitted by the Contractor in accordance with the electrical acceptance testing.

*Note: In addition to the final arc-flash analysis, the final power system studies include load flow and fault-current calculations, and an overcurrent protective device (OCPD) coordination study based on the actual equipment to be installed for the project.*

Information to be determined and applied to electrical equipment:

- Arc-Flash Protection Boundary
- Arc-flash incident energy calculated in accordance with IEEE Std 1584a™
- Working distance calculated in accordance with IEEE Std 1584a™
- NFPA 70E Hazard / Risk Category Number or the appropriate personal protective equipment (PPE) for operations with doors closed and covers on.

*Note: Typical operations include operating circuit breakers, fused switches, and meter selector switches.*

- System phase-to-phase voltage
- Condition(s) when a shock hazard exists (e.g. “With cover off”)
- Limited Approach Boundary as determined from NFPA 70E, Table 130.2(C)
- Restricted Approach Boundary as determined from NFPA 70E, Table 130.2(C)
- Prohibited Approach Boundary as determined from NFPA 70E, Table 130.2(C)
- Unique equipment designation or code (described under “Component Identification”)

below)

- Class for insulating gloves based on system voltage (e.g., Class 00 up to 500V)
- Voltage rating for insulated or insulating tools based on system voltage (e.g., 1000V)
- Date that the hazard analysis was performed.
- “Served from” circuit directory information including the serving equipment designation, location (e.g., room number), circuit number, and circuit voltage / number of phases / number of wires.
- If applicable, the “serves” circuit directory information including the served equipment designation, location (e.g., room number), circuit number, and circuit voltage / number of phases / number of wires.

An abbreviated warning label may be used where it has been determined that no dangerous arc-flash hazard exists in accordance with IEEE 1584a™, paragraph 9.3.2.

Use a “DANGER” label where the calculated arc-flash incident energy exceeds 40 cal/cm.

#### Component Identification

Unique Equipment Designation – Identify electrical equipment on the drawings and on the equipment by assigning a unique alphanumeric code that identifies the equipment by:

- Function/System – e.g., “P” for a normal power panelboard and “EP” for an emergency power panelboard),
- Distribution System Operating Voltage - e.g., “H” for 480/277V and “L” for 208/120V.
- Location – e.g., “2<sup>nd</sup> floor” or “Electrical Room 211.”

#### Equipment Nameplates

Install electrical equipment nameplates containing the following three types of information:

- Type A – Circuit Directory Information: Provide circuit number; equipment served or served from; location of equipment served or served from; voltage/number of phases/ number of wires.
- Type B – General or Operational Information: Basic instructions or specific operating procedures such as special switching procedures for a load transfer scheme. These

nameplates may be omitted from equipment that contains arc-flash and shock-hazard warning labeling with the required circuit directory information.

- Type C – Emergency Operations: Information concerning emergency shutdown procedures for room, equipment, and building isolation in the event of a fire or other emergency.

#### Diagrams and Operating Instructions

Post and maintain diagrams, operating instructions and emergency procedures for electrical systems and major equipment. The documents should consist of simplified instructions, procedures, and diagrams of equipment, controls and operation of systems for selector switches, main-tie-main transfers, ATS-bypass, UPS-bypass, etc. Post and maintain an up-to-date one-line diagram of the electrical system adjacent to the service-entrance equipment.

#### Emergency System Equipment Identification

Install markers to identify emergency system transfer switches, generators, switchgear, transformers, motor control centers, panelboards, starters, safety switches, pull boxes, and cabinets as components of the emergency system.

#### Warning Signs, Markers, & Device Labels

- Install warning signs that conform to ANSI Z535.2 and meet the intent of the OSHA and *NEC*<sup>®</sup> danger and caution specifications on electrical equipment containing hazardous voltages (e.g. switchgear, switchboards, transformers, motor control centers, panelboards, starters, safety switches, busways, pull boxes, and cabinets).
- Install voltage markers on electrical equipment (e.g. switchgear, transformers, motor control centers, panelboards, starters, safety switches, pull boxes, cabinets, etc.).
- Install wire markers on power, control, instrumentation, fire alarm, and communications circuit wires.
- Install labels on receptacle outlets and light switches indicating circuit number, panelboard, and voltage.

#### **Electrical Demolition**

Remove abandoned electrical distribution equipment, utilization equipment, outlets, and the accessible portions of wiring, raceway systems, and cables back to the source panelboard, switchboard, switchgear, communications closet, or cabinet. Abandoned wiring and raceways can result from actions that include the following:

- Equipment is removed or relocated.
- Fixtures are removed or relocated.
- System is no longer used.
- There is no demonstrable near term future use for the existing circuit or raceway system.

Leave abandoned electrical equipment, conductors, and material in place only if one or more of the following conditions exist:

- The removal requires the demolition of other structures, finishes, or equipment that is still in use. An example is abandoned conduit above an existing plaster ceiling.
- Removal is not feasible due to hazards, construction methods, or restricted access.
- Removal of abandoned conductors may damage conductors that must remain operational.

Remove conduits, including those above accessible ceilings, to the point that building construction, earth, or paving covers them. Cut conduit beneath or flush with building construction or paving. Plug, cap, or seal the remaining unused conduits. Install blank covers for abandoned boxes and enclosures not removed.

Extend existing equipment connections using materials and methods compatible with the existing electrical installation and this division.

Restore the original fire rating of floors, walls, and ceilings after electrical demolition.

Use approved lock-out/tag-out procedures to control hazardous energy sources. Assure that an electrically safe work condition exists in the demolition area before beginning demolition. Where possible, disconnect the building from all sources of electrical power before beginning demolition.

### **Electrical Acceptance Testing**

Perform electrical acceptance testing and inspections in accordance with the current edition of the International Electrical Testing Association (NETA), *Acceptance Testing Specification (ATS)*.

Perform acceptance testing, inspection, function tests, and calibration to assure that installed electrical systems and components, both Contractor and User-supplied, are:

- Installed in accordance with design documents and manufacturer's instructions.
- Tested and inspected in accordance with applicable codes and standards (e.g. NFPA 110 and NFPA 111).

- Ready to be energized.
- Operational within industry and manufacturer’s tolerances.

## Medium-Voltage Electrical Service & Distribution

### System Operating Characteristics

The medium-voltage electrical service and distribution system that serves each A&M System-Member campus is operated as an electric utility system in the manner by which power is distributed and utilized at the point of delivery. The operating characteristics, grounding, load connections, utilization voltages, and short-circuit current available at the point of service vary from campus to campus, as does the primary service provider, depending on if the campus owns and operates the system or a loaned and operated by a local utility company. This information is summarized in the following table:

| Texas A&M University System-Member Campuses<br>Electric Utility Distribution & Utilization System Characteristics |      |       |          |       |        |      |            |       |       |       |        |        |        |
|---|------|-------|----------|-------|--------|------|------------|-------|-------|-------|--------|--------|--------|
| System Characteristics  | TAMU | TAMUG | TARLETON | PVAMU | TAMUCC | TAMU | KINGSVILLE | WTAMU | TAMUC | TAMUT | TAMHSC | TAMUCT | TAMUSA |
| <b>Distribution System</b>  |      |       |          |       |        |      |            |       |       |       |        |        |        |
| Nominal Voltage   | SV3  |       | SV2      | SV2   | SV2    | SV2  | SV2        | SV2   | SV2   | SV2   | SV2    |        | SV5    |
| Grounding   | LRG  |       | SG1      | SG1   | SG1    | SG1  | SG1        | SG1   | SG1   | SG1   | SG1    |        | SG1    |
| Load Connections  | Δ Y  | Δ Y   | Δ Y      | Δ Y   | Δ Y    | Δ Y  | Δ Y        | Δ Y   | Δ Y   | Δ Y   | Δ Y    | Δ Y    | Δ Y    |
| Short-Circuit Current   |      |       |          |       |        |      |            |       |       |       |        |        |        |
| System Configuration  |      |       |          |       |        |      |            |       |       |       |        |        |        |
| Elec. Utility Co. / Provider  | EU1  |       | EU2      | EU3   | EU4    | EU4  | EU4        |       | EU5   | EU6   | EU7    |        | EU8    |
| Elec. Utility Co. F&I Equip.  | No   |       | No       | No    | Yes    | No   | Yes        | No    | No    | Mix   | Mix    |        | No     |
| <b>Utilization System</b>   |      |       |          |       |        |      |            |       |       |       |        |        |        |
| Central Plant Chillers  | UV1  | N/A   | N/A      | N/A   | N/A    | N/A  | N/A        | N/A   | N/A   | N/A   | N/A    | N/A    | N/A    |
| Motors 500 HP & Larger  |      |       |          |       |        |      |            |       |       |       |        |        |        |
| Other Large Loads   |      |       |          |       |        |      |            |       |       |       |        |        |        |
| Grounding   | LRG  |       |          |       |        |      |            |       |       |       |        |        |        |
| <i>Notes:</i>   |      |       |          |       |        |      |            |       |       |       |        |        |        |
| 1. Some of the fields remain incomplete at this time. These will be completed with the next issue of the FDG.     |      |       |          |       |        |      |            |       |       |       |        |        |        |
| 2. Refer to the next page for a table that defines the various alphanumeric codes in the fields above.            |      |       |          |       |        |      |            |       |       |       |        |        |        |

| Codes for Electric Utility Distribution & Utilization System Characteristics |      |  |
|--|------|--|
| Item / Category  | Code | Information / Description  |
| Distribution System  | SV1  | 12.47 kV, 3-phase, 3-wire, delta / ungrounded wye, 60Hz              |
|  | SV2  | 12.47 kV, 3-phase, 4-wire, delta / solidly-grounded wye, 60Hz        |
| Nominal  | SV3  | 12.47 kV, 3-phase, 4-wire, delta / low-resistance-grounded wye, 60Hz |

**Design Criteria**  
**Division 26 – Electrical**

| Codes for Electric Utility Distribution & Utilization System Characteristics |      |  |
|--|------|--|
| Item / Category  | Code | Information / Description  |
| Voltage  |      | <i>Note: The ungrounded (neutral) conductor is grounded through a low-impedance resistor to limit the current in the event of a ground fault.</i>  |
|  | SV4  | 13.2 kV, 3-phase, 3-wire, delta / ungrounded wye, 60 Hz  |
|  | SV5  | 13.2 kV, 3-phase, 4-wire, delta / solidly-grounded wye, 60 Hz  |
|  | SV6  | 4.16 kV, 3-phase, 4-wire, delta / 2.4 kV, 3W, 60Hz<br><i>(Omit if 4.16 kV isn't used for primary distribution at any campus; consider adding a separate category for "multiple/sub-distribution primary voltages" used to serve special equipment such as large motors.)</i> |
| Distribution System Grounding  | SG1  | Solidly-grounded wye   |
|  | SG2  | Primary: TBD<br>Secondary: TBD   |
|  | SG3  | Primary: TBD<br>Secondary: TBD   |
|  | LRG  | Low-resistance-grounded wye  |
| Distribution System Load Connections   | LC1  | TBD  |
|  | LC2  | TBD  |
|  | LC3  | TBD  |
|  | LC4  | TBD  |
|  | LC5  | TBD  |
| Distribution System Short-Circuit Current                                    | SC1  | TBD  |
|  | SC2  | TBD  |
|  | SC3  | TBD  |
|  | SC4  |  |
|  | SC5  |  |
| Distribution System Configuration  |      |  |
| Electric Utility Company / Provider  | EU1  | Combined Heat & Power with Brazos Power Cooperative  |
|  | EU2  | Texas New Mexico Power Company   |
|  | EU3  | San Bernard Electric Power CO-OP   |
|  | EU4  | American Electric Power Company (AEP)  |
|  | EU5  | TXU  |
|  | EU6  | SWEPCO – Arkansas  |
|  | EU7  | BTU  |
|  | EU8  | City Public Service (CPS)  |
| Electric Utility Company F&I Equipment                                       |      |  |
| Utilization System Central Plant Chillers                                    | UV1  | 12.47 kV / L-L & 4.16Y / 2.4 kV, 3W, 60 Hz   |
|  | UV2  | 4160 / 2.4 kV, 3W  |
|  | UV3  |  |
|  | UV4  |  |
|  | UV5  |  |



| Codes for Electric Utility Distribution & Utilization System Characteristics |      |                           |
|--|------|---------------------------|
| Item / Category  | Code | Information / Description |
| Utilization System Motors 500 HP & Larger                                    |      |                           |
|  |      |                           |
|  |      |                           |
| Utilization System Other Large Loads   |      |                           |
|  |      |                           |
|  |      |                           |
| Utilization System Grounding   |      |                           |
|  |      |                           |
|  |      |                           |

**Design Guidance**

- Select an optimum standard medium-voltage utilization system level for large loads that results in the highest operational efficiency and the least life-cycle cost.
- Serve large loads at one of two standard medium-voltage utilization system levels.
- Confirm the available short-circuit current at the point of service or connection to the existing utility source with the University’s local electric power provider. For those campuses that own and operate their own medium-voltage or “primary” distribution system, it may be helpful to first contact the electrical supervisor for that university’s Physical Plant to obtain this information.

*Note: For projects that require one or more medium-voltage transformers to supply low-voltage power to a building or facility, it is generally acceptable to assume for design purposes, in the calculation of maximum short-circuit current, that the utility source has an infinite bus impedance relative to the secondary windings of each medium-voltage transformer supplied from it. Refer to IEEE 242, Section 2.7 for additional information and guidance on the calculation of short-circuit values.*

**System Description**

Medium-voltage distribution circuits in the well-developed areas of a campus generally consist of multiple single-conductor insulated copper conductors routed in a multi-duct underground ductbank/manhole system with radial and looped circuits switched manually via sectionalizing switchgear.

The switchgear supply power from the campus utility distribution system “grid” to the primary windings of one or more medium-voltage transformers located within the project site through an extension of the underground ductbank/manhole system.

Major loads in such areas may have dedicated radial feeders from utility substations.

Distribution circuits in less developed areas typically provide electrical services to individual buildings and other permanent structures radially from aerial conductors; however, the installation of permanent overhead distribution is not permitted for new construction at any campus.

The portion of the utility distribution system supplying a typical TAMUS project originates at the point of service or connection to the existing utility or campus-owned supply line via switchgear and terminates at the primary windings of the medium-voltage transformer(s) that serve(s) the project load at a lower utilization voltage.

The load for a TAMUS project typically consists of a single building or facility located on a well-defined project site. Each building is served from the campus primary distribution system through one outdoor sectionalizing switchgear containing two switched mains and one or two switched feeder taps.

The main or incoming feeder is “looped” through the pair of switched mains, thereby providing continuity of the main feeder as well as the option to isolate a portion of it.

Depending on the magnitude of the load and the level of reliable normal power required for the project, one or both of the switched feeder taps in the switchgear may be used to supply the building or buildings from one or two service transformers.

Smaller buildings that do not require more than an average level of service reliability are usually served by a single transformer via one radial feeder from the switchgear, in which case the other switch may be reserved as a spare to supply temporary backup power to the building.

Buildings that require two service transformers, either because of a high demand load and/or a requirement for a high level of service reliability, are most often served by two radial feeders that each emanate from one of the two switched taps contained within the same switchgear and are terminated at the primary bushings of each transformer.

Additional alternatives for supplying one or more buildings from the utility distribution system are possible because TAMUS standards require that all medium-voltage transformers be provided with loop/dual-feed primary bushings. Refer to the heading “Medium-Voltage Transformers” for additional information.

Unless noted otherwise in the project-specific Program of Requirements (POR), any modifications necessary to extend or upgrade the campus utility distribution system to supply electrical service to a new project or project site must be fully funded by that project. Therefore, all utility distribution system components including cables, ductbanks, manholes, switchgear, service transformers, equipment pads, and similar construction items necessary to support or contain utility system components must be furnished and installed by the Construction Contractor selected for each project.

### **Location & Routing of Primary Distribution**

Determine the maximum demand load for the project as soon as possible during the design phase so that the Owner may determine which utility distribution system circuit(s) is (are) most suitable to supply the project and identify the physical point(s) of connection to it, e.g., the existing manhole(s) and switch(es) that may be used, and any modifications of the campus medium-voltage infrastructure that would be required for inclusion in the project scope of work.

Determine the routing of ductbanks and the locations of manholes, medium-voltage transformers, electricity meters, emergency/standby generators, and other outdoor electrical equipment during the Design Development phase.

Coordinate the placement of proposed underground ductbanks and manholes with the Project Civil Engineer.

Provide sufficient horizontal and vertical separation from other underground utilities. The minimum outside-to-outside surface clearance between medium-voltage ductbanks and other utilities is 12 inches for vertical crossings and 12 inches for parallel runs.

Provide at least 20 feet of separation between exterior building foundations and the outside walls of existing in-use and new medium-voltage electrical manholes and ductbanks.

*Note: Where a proposed building cannot satisfactorily be placed within the project site boundary without compromising the minimum 20-ft. separation from an existing in-use medium-voltage manhole or ductbank, the project shall relocate the existing infrastructure accordingly. Abandoned manholes and ductbanks not scheduled for future use are excluded from this requirement.*

Following are additional considerations and requirements for the physical arrangement of outdoor medium-voltage electrical equipment:

- Coordinate the locations of proposed outdoor electrical equipment with the Project Architect.
- Minimize any adverse visual effects of equipment on architectural and landscaping features.
- Minimize audible effects associated with the operation of transformers and generators.
- Provide adequate and required access to equipment for the safe inspection, maintenance, and operation by personnel, and to allow for its proper installation and removal without the need to remove, relocate, or disassemble other permanent equipment installations or structures in the area.

*Note: Later sections of this Division present guidance and special requirements for working space and dedicated equipment space in the sections that address specific medium-voltage equipment. For example, special requirements apply to the proper location, operation, and maintenance of medium-voltage transformers, depending on the type used and whether they are installed indoors or outdoors. These requirements are described under the heading “Medium-Voltage Transformers” below.*

**Medium-Voltage Cable**

Shielded MV105 Cable

Provide medium-voltage shielded power cables that are NTRL-listed as Type MV105 for use in raceways, trays, underground ductbanks, manholes, vaults, and within switchgear and equipment of sufficient interior dimensions to allow for the proper bending & and termination of shielded cables.

Comply with the *NEC*®, IEEE C2™, ICEA S-93-639 / NEMA WC-74, and UL 1072.

Select voltage ratings for power cables and terminations based on the operating voltage of the medium-voltage distribution system as follows:

| Distribution System Operating Voltage | Power Cable Nominal Voltage Rating |
|---------------------------------------|------------------------------------|
| 4,160 volts                           | 5kV                                |
| 5,000 volts to 15,000 volts           | 15kV                               |
| 25,000 volts                          | 25kV                               |
| 35,000 volts                          | 35kV                               |

Specification

- Conductor: Single uncoated annealed copper conductor with Class B stranding.
- Strand Screen: Extruded semi-conducting ethylene-propylene rubber (EPR).
- Insulation: 133% EPR 140 mils thick for 5kV & 220 mils for 15kV.
- Insulation Screen: Extruded semi-conducting EPR.
- Shielding: Copper tape 5 mils thick helically applied with a minimum of 12.5% overlap.
- Jacket: Chlorosulfonated polyethylene (Hypalon), 80 mils thick.
- Continuous Operating Temperature: 90°C

*Note: Operating temperature is limited to 90°C because PVC power ducts are listed for*

*90°C conductors.*

- Emergency Temperature Rating: 105°C
- Short-Circuit Rating: 250°C
- Conductor Sizes (for 15kV only): AWG Nos. 1, 1/0, 4/0, & 500kcmil.

#### Non-shielded MV105 Power Cable

Use non-shielded medium-voltage power cables only for short jumpers within switchgear or transformer enclosures where it is not feasible to install shielded cables due to inadequate space for bending or terminating shielded cables.

Use non-shielded medium-voltage transformer cable with 133% EPR / 140 mils thick for 5kV and 133% EPR / 220 mils thick for 15kV insulation, chlorosulfonated polyethylene (Hypalon) jacket.

Conductor AWG Sizes (for 15kV only): 1, 1/0, 4/0, & 500kcmil.

Obtain approval from the Owner for each installation of non-shielded medium-voltage cable.

#### Acceptable Manufacturers

- General Cable
- Kerite
- Okonite
- Pirelli

#### Medium-Voltage Cable Terminations

Terminating materials must be compatible with the cable supplied.

Submit proof of the acceptability by the cable manufacturer of any splicing or terminating materials.

Separable Insulated Connectors: Specify pre-molded EPDM-type, submersible, fully shielded, separable insulated connectors for use with MV105 power cable as specified above. Connector system components shall comply with IEEE Std 386™, *Separable Insulated Connector Systems for Power Distribution Systems Above 600V*.

Match voltage-class ratings of cable at 5kV, 15kV, or 25kV voltage-class. Provide 200A-rated load break elbow connectors for outdoor terminations at medium-voltage transformers and switchgear with switch-ways rated at 200A continuous, and 600A-

rated dead break elbow connectors for terminations at medium-voltage switchgear with switch-ways rated at 600A continuous.

Indoor Terminators: Silicone rubber, cold shrink, tubular or skirted.

Outdoor Terminator: Silicone rubber, cold shrink, skirted.

Acceptable Manufacturers:

- Elastimold
- RTE
- 3M

Medium-Voltage Cable Testing

Upon completion of the installation, the Owner shall secure and pay for the services of a qualified, independent testing firm to conduct a test of all medium-voltage cable, including terminations, as part of the electrical acceptance test project phase.

The testing firm shall perform a high-potential proof test using a non-destructible DC testing device such as a “Kenotron” Westinghouse “High-Pot Tester”, or approved equal, capable of generating approximately 100,000 VDC under normal leakage conditions of acceptable cable.

All cables shall be tested in place with all splices and pothead terminations made up but not connected to switchgear or any other equipment, load device, or dead-end seal. Cables with dead-end seals shall be temporarily opened and then re-sealed.

In case of failure during the test, the Contractor shall locate the faulty splice, termination, or cable section and notify the Owner before making any repairs.

The testing firm shall submit to the Project A/E five copies of all test reports for review by the Engineer-of-Record. Should the test reports indicate, in the opinion of the Owner, that the condition of the new cable is unsatisfactory, the Contractor shall make all repairs and/or replacements to the satisfaction of and no additional cost to the Owner.

Additional tests using the same testing firm shall also be made at the Contractor’s expense on all repaired sections.

The Owner will not accept any cable installations until satisfactory certified proof test reports are obtained.

## Raceway Systems for Medium-Voltage Cables

### Design Guidance

Perform calculations to determine pulling tensions and sidewall pressures for all duct or conduit runs of medium-voltage power cable.

Design raceway systems so that the calculated pulling tensions and sidewall pressures will not exceed the cable manufacturer's recommendations.

Lacking manufacturer's recommendations, use the following maximum values:

Cable tension:

- 0.008 lb./cmil for up to 3 conductors, not to exceed 10,000 pounds.
- 0.0064 lb./cmil for more than 3 conductors, not to exceed 10,000 pounds.
- 1000 lbs. per basket grip.

Sidewall pressure: 500 lbs./ft

The maximum length of raceways between cable pulling points shall be the lesser of 400 feet or a maximum of 90° in total horizontal bends between cable pulling points.

### Aboveground Installations

Within the perimeter of buildings, install aboveground medium-voltage cables in rigid metal conduit.

In areas protected with fire sprinklers, terminate conduits entering equipment enclosures from above with water sealing fittings.

Install voltage markers on all conduits containing medium-voltage cables.

## Medium-Voltage Switchgear

### Indoor Medium-Voltage Switchgear

For facility-level medium-voltage switchgear lineups and unit substation switchgear, provide metal-enclosed interrupter switchgear conforming to IEEE C37.20.3, *Standard for Metal-Enclosed Switchgear*, with current-limiting E-rated power fuses conforming to IEEE C37.46, *Standard Specifications for Power Fuses and Fuse Disconnecting Switches*.

For facility-level medium-voltage switchgear applications that either exceed the current capacity of fused equipment or require complex or high-speed switching operations, use metal-clad switchgear with vacuum circuit breakers conforming to:

- IEEE C37.20.2, *Standard for Metal-Clad and Station-Type Cubicle Switchgear*
- IEEE C37.04, *Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*
- ANSI C37.06, *Standard for Switchgear – AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities*
- IEEE C37.09, *Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*

Provide 5kV medium-voltage switchgear having the following minimum ratings:

- 60Hz one-minute withstand voltage at mean sea level: 22kV; this rating may be obtained through insulation coordination with surge arresters.
- BIL at mean sea level: 75kV; this rating may be obtained through insulation coordination with surge arresters.
- Short-circuit rating: Greater than the available short-circuit current.

Provide 15kV-class medium-voltage switchgear with the following minimum ratings:

- 60Hz one-minute withstand voltage: 42kV at mean sea level; this rating may be obtained through insulation coordination with surge arresters.
- BIL at mean sea level: 95kV; this rating may be obtained through insulation coordination with surge arresters.
- Short-circuit rating: Provide equipment with a short-circuit rating greater than the available short-circuit current and not less than 25kA RMS symmetrical.

Provide intermediate-class, metal-oxide surge arresters in 15kV-class medium-voltage switchgear conforming to IEEE Std C62.11, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits*. Apply arresters in accordance with IEEE Std C62.22-1991, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems* or as recommended by the arrester manufacturer.



## Outdoor Medium-Voltage Switchgear

### Pad Mount Switches

#### Description

- For purposes of this Section, “padmount switches” are understood to consist of a single self-supporting enclosure containing interrupter switches.
- Padmount switches are restricted to outdoor use. A padmount switch may include power fuses and accessory compartments.
- Padmount switches shall be manufactured in accordance with IEEE C37.74.

#### Application

- Padmount switches are typically used for sectionalizing applications in the medium-voltage distribution system.

*Note: Within the limitations of their current-carrying capability, interrupting duty and available configurations, padmount switches typically offer the lowest-cost switching solution.*

- Because of the relatively limited short-circuit capacity of padmount switchgear, available fault current at the proposed switch location must be carefully considered.

#### Installation

- Install padmount switches atop or immediately adjacent to manholes.
- Route cables to padmount switches through manholes.
- Design a foundation for a padmount switch.

#### Clearances

- Design installations of padmount switches to permit maintenance access. Design the installation of padmount switches to ensure 10 feet of clear working space in front of the switch enclosure doors for the full width of the enclosure.

*Note: In areas where vehicle parking may be possible, bollards, curbs or other structures should be installed to keep vehicles out of the working space. The sides of switches without doors or auxiliary compartments containing electrical control or instrumentation devices do not need working space greater than 30 inches for personnel access. For switches with side-mounted accessories such as fuse storage*

*compartments or crank-type switch operators, this access space is to be measured from the outer face of the accessory or the end of the crank handle.*

- Auxiliary compartments with electrical control or instrumentation devices must be provided with working space in conformance with NESC Rule 125.

### **Metal-Enclosed Interrupter Switchgear**

#### Description

- For purposes of this Section, “metal-enclosed interrupter switchgear” is understood to be equipment consisting of interrupter switches housed in individual steel compartments. Switching devices are fixed (not draw out). Busses are typically exposed when the compartment door is open. The switchgear may include fuses, sensing and metering devices and control equipment, but not power circuit breakers.
- Metal-enclosed interrupter switchgear is available with enclosures suitable for indoor or outdoor installation.
- Metal-enclosed interrupter switchgear shall be manufactured in accordance with IEEE C37.20.3.

#### Application

- Metal-enclosed interrupter switchgear differs from padmount switches in its higher continuous current and interrupting rating, and wider availability of custom features. Metal-enclosed interrupter switchgear is commonly used as the primary disconnecting means for unit substations.
- For application of metal-enclosed interrupter switchgear, consultation with the equipment vendors is recommended.
- Manufacturers’ ratings do not take into consideration the effect of solar radiation on metal-enclosed interrupter switchgear installed outdoors. Use IEEE Standard C37.24 to calculate the derating of the continuous current rating of switchgear exposed to the sun.

### **Metal-Clad Switchgear**

#### Description

- For purposes of this Section, “metal-clad switchgear” is understood to be equipment consisting of individual steel compartments with draw-out switching devices. Switching devices may be load-break interrupter switches or power circuit breakers. The switchgear may include fuses, sensing and metering devices and control

equipment.

- Metal-clad switchgear is available with enclosures suitable for indoor or outdoor installation.
- Metal-clad switchgear shall be manufactured in accordance with IEEE C37.20.2.

#### Equipment

- Specify General Electric Power/VAC vacuum metal-clad circuit breaker elements for use on 15kV-class systems.
- Note that the requirement for GE Power/VAC equipment is not intended to unreasonably limit the market for the supply of switchgear equipment. The limitation extends only to the interrupter devices (the vacuum bottles) and the removable circuit breaker mechanism (the breaker” truck”). The switchgear control systems, buswork, and enclosures may be assembled by a qualified fabricator other than General Electric.

#### Application

- Metal-clad offers the most flexible means of control and protection for power systems. Sophisticated protective relay schemes are readily applied to metal-clad switchgear. Of the three available types of switchgear, metal-clad is the most expensive.
- For application of metal-enclosed interrupter switchgear, consultation with the equipment vendors is recommended.
- Specify outdoor installations of metal-clad switchgear with walk-in aisle-type enclosures.
- Provide ventilation (and air conditioning if required) as necessary to ensure that interior temperatures do not exceed 95°F.
- Manufacturers’ continuous current ratings do not take into consideration the effect of solar radiation on metal-clad switchgear installed outdoors. Use IEEE Standard C37.24 to calculate the derating of the continuous current rating of switchgear exposed to the sun.

### **Medium-Voltage Transformers**

Specify dry-type units for locations inside the building and mineral oil-filled padmounted-type units for locations outdoors.

#### Indoor Dry-Type Medium-Voltage Transformers

Use **dry-type** transformers conforming to IEEE Std C57.12.01, *Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings*, where liquid containment is not practical. Use dry-type transformers having an 80°C winding temperature rise over a 30°C average, 40°C maximum ambient. Use cast epoxy resin transformers to serve critical loads or where the transformer is in a dirty environment. Use vacuum pressure impregnated or cast epoxy resin transformers to serve non-critical loads and where the transformer is in a clean environment. Specify copper windings only.

Install medium-voltage dry-type transformers indoors only.

Install indoor transformers in vaults or rooms with a fire-resistance rating of not less than 1 hour.

Doors in transformer vaults or rooms shall be fire-rated and swing outward in the direction of egress.

- Equip doors with panic hardware.
- Fire rating of doors shall match fire rating of room or vault.
- Provide door opening adequate for moving largest equipment in the room or vault.

Locate transformers a minimum of 36 inches from building walls.

Provide ionization type smoke detectors and automatic sprinkler protection for indoor medium-voltage transformer vaults or rooms. Connect ionization-type smoke detectors to the building fire alarm system.

Provide automatic sprinkler protection system with a discharge density of not less than 0.20 gpm/sq. ft. over floor area of the transformer vaults, rooms, or spaces.

Provide mechanical cooling or ventilation powered from a reliable source to maintain transformer vaults or rooms within temperature limits appropriate for transformer operation.

Provide power ventilation system from an emergency or standby power source if available.

Specify primary overcurrent protection devices to provide through-fault protection of transformer in accordance with IEEE Std 242™.

Select distribution-class, gapless-type metal-oxide surge arresters for connection to the primary side of the transformer to provide additional protection against abnormally high voltage transients. Specify the maximum continuous operating voltage (MCOV) of the arrester according to its voltage-class rating. Apply arresters in accordance with IEEE Std C62.22, *IEEE Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems* or as recommended by the arrester manufacturer.

### Outdoor Oil-Filled Pad Mounted Medium-Voltage Transformers

Install oil-filled medium-voltage transformers outdoors only.

Provide outdoor, pad-mounted, mineral oil-insulated, self-cooled medium-voltage transformers with integral dead-front loop-feed primary and live-front radial secondary cable terminating compartments. Windings shall be copper; aluminum windings are not acceptable.

Transformers shall be designed, constructed, and tested in conformance with IEEE C57.12.22™, *Requirements for Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (High Voltage, 16340 Volts and Below; 2500 KVA and Smaller)*.

Transformers shall be designed to operate at a 65 °C average winding temperature rise over a 30 °C average, 40 °C maximum ambient temperature.

Furnish each transformer with the following accessories:

- Oil-immersed, load-break, bayonet fuse-holders with expulsion style fuses.
- Oil-submersible protector with current-limiting fuses rated for 50kAIC. Current-limiting fuses shall be placed in series with expulsion style fuses.
- Distribution-class, metal-oxide varistor elbow (MOVE) type surge arresters.
- Two 2-1/2% above and two 2-1/2% below rated-voltage, full-current-rated for changing under no load. Include externally-mounted handle for tap-changer.

### Acceptable Manufacturers

- ABB
- Cooper
- Square D
- GE

### Installation

- Design a concrete foundation for the transformer. If required, provide an oil-containment system integral to the foundation in accordance with EPA regulations.
- Install in accordance with the *NEC*® and the Factory Mutual Insurance Company Loss Prevention Data Sheet 5-412.

### Transformer Capacity

Base transformer capacity on load calculations per the requirements in *NEC*® and this Chapter and loading guidance in the following IEEE standards as applicable:

- IEEE C57.91-1981, *Guide for Loading Mineral-Oil-Immersed Overhead and Pad-*

*Mounted Distribution Transformers Rated 500 kVA and Less with 65°C or 55°C Average Winding Rise*

- IEEE C57-92-1981, *Guide for Loading Mineral-Oil-Immersed Overhead and Pad-Mounted Distribution Transformers Up to and Including 100 MVA with 65°C or 55°C Average Winding Rise.*
- IEEE C57-91-1995, *IEEE Guide for Loading Mineral-Oil-Immersed Transformers.*
- IEEE C57.96, *Guide for Loading Dry-Type Distribution and Power Transformers*

*The IEEE C57-91-1995 Guide combines the data previously issued in the IEEE Guides C57.91-1981, C57.92-1981, and C57.115-1991 (redesignated as Std. 756). It also updates the data and presents equations that approximate the empirical data previously presented in tabular form. The designer may apply either method.*

Use the following loading factors to determine transformer capacity.

- Average 24-hour ambient temperature

Use the highest historical average (mean) daily temperature recorded at the University campus or at a location nearest the campus for which accurate data are available, such as the nearest airport or city. This data may be obtained from the National Weather Service at <http://www.nws.noaa.gov> or other source with similar reliable and/or official data. Refer to the appropriate sections in the ANSI/IEEE standards referenced above for further guidance concerning the determination of ambient temperature for use in the selection of the “Peak Load Per Unit” or peak load factor presented in the series of tables in both publications.

*According to Weather.com, the highest 24-hour average temperature for College Station, TX (zip code 77843) is 30°C and occurred on August 4 and 5.*

- Elevation: Determine actual site elevation according to the United States Geological Survey (USGS) 1:25000 topographic map. The USGS website is at <http://www.usgs.gov>.
- Rated average winding temperature rise: 65°C per IEEE Standard C57.12.00-2006, Paragraph 5.11.1.1.
- Transformers serving facilities having a significant daily load cycle may be operated with the peak load above the transformer nameplate rating as long as normal transformer life expectancy is maintained; refer to the IEEE transformer-loading guides listed above.

For single-ended services, the calculated load using the NEC® plus future load growth shall not exceed the calculated transformer self-cooled peak loading capability.

*Example 1 – For building or facility located on a campus in College Station with a significant daily load cycle: 685kVA calculated load per the NEC® plus 137kVA future load growth of 20% = 822kVA. Select a pad-mounted transformer with a standard base rating equal to or greater than  $822kVA / 1.68^* = 489kVA$ , or 500kVA, and a 2-hour peak loading capability of approximately  $500kVA \times 1.68^* = 840kVA$  based on Table 6 in IEEE C57.91-1981.*

*\*The peak load factor (per unit) assuming an ambient temperature of 30°C.*

*Base the secondary service conductors on the 822kVA calculated load.*

For double-ended services, the calculated closed-tie load using the NEC® plus future load growth shall not exceed the calculated forced-air cooled peak loading capability of either transformer.

*Example 2 – For a building or facility located on the Texas A&M International University in Laredo, TX with a significant daily load cycle: 2,625kVA calculated “closed-tie” load per the NEC® plus 263kVA future load growth of 10% = 2,888kVA. With special Owner permission, two 2000/2300kVA (OA/FA) outdoor unit substation transformers, each with an FA rating equal to or greater than  $2,888kVA / 1.35^{**} = 2,139kVA$ , or 2,300kVA, and a 2-hour FA peak loading capability of approximately  $2,300kVA \times 1.35^{**} = 3,105kVA$ , may be selected based on Table 3(f) in IEEE C57.92-1981.*

*\*\*The peak load factor (per unit) assuming an ambient temperature of 32°C, which must be interpolated from the table values between the 30°C and 40°C columns.*

*Base the secondary service conductors on the 2,888kVA calculated load.*

## Low-Voltage Electrical Service & Distribution

### System Description

The scope of this section includes that portion of the low-voltage or “secondary” distribution system originating at the point of connection to the secondary windings of the medium-voltage transformer(s) serving the building, the main service-entrance equipment and disconnecting means up to and including the 480V and/or 208V switchgear, panelboards, and low-voltage dry-type transformers at which each 480V and/or 208V feeder terminates.

Furnish, install, and test all equipment and materials as necessary for a complete system.

### **Secondary System Characteristics**

Design building service systems with the appropriate supply voltage to cost-effectively serve the load. Refer to Clause 3.3 of IEEE Std 141™ and Clause 3.3 of IEEE Std 241™. Following are general design guidelines for selection of the building service voltage based on estimated demand and load characteristics. Other factors not considered here may change the basis of design so that the selection of a different service voltage would be more practicable and/or cost-effective.

- Less than 50 kW demand and no 3-phase load: 120/240V, single phase.
- Less than 250 kW demand and largest motor 20 HP or smaller: 208Y/120V, 3-phase.
- More than 250kW demand or largest motor larger than 20 HP: 480Y/277V, 3-phase.
- Motors 500 HP or larger: 4.16kV.

Unless otherwise required by the *NEC*®, use solidly grounded building service and distribution systems (e.g. 120/240V, 208Y/120V, 480Y/277V). Convert existing facilities with ungrounded service systems to solidly grounded service systems during major renovations or service equipment replacements.

Select the grounded (neutral) conductor for services and feeders as follows:

- If the line-to-neutral connected load is 5% or less of the total connected load, size the grounded conductor based on *NEC*® minimum requirements.
- If the line-to-neutral load exceeds 5% of the connected load, make the grounded conductor ampacity no smaller than that of the phase conductors.
- If the line-to-neutral load exceeds 57% of the connected load, and the circuit serves high-harmonic loads, make the grounded conductor ampacity 200% that of the phase conductors. Coordinate the size and quantity of neutral conductors with panelboard manufacturer's installation instructions; UL 67 requires that the cable terminations for 200% rated neutral bars match the rating of the neutral.

Connect utilization equipment to the service in the following manner:

- Connect major three-phase motor and power loads at the service line-to-line voltage.
- Connect HID and fluorescent lighting at the service line-to-neutral voltage.
- Connect 120V convenience receptacles, incandescent lighting, and 208V single-phase and three-phase equipment to separately derived 208/Y120V systems using dry-type step-down transformers if the service is 480Y/277V.



- Install one or more separately derived, isolated-ground power systems as appropriate to cost-effectively serve groups of computer and electronic instrument loads that are susceptible to common-mode noise. Derive each isolated-ground power system using a K-factor rated, dry-type transformer with electrostatic shielding between primary and secondary windings served by dedicated feeders if the service is either 480Y/277V or 208Y/120V. Susceptible computer and electronic instrument loads include:

Equipment within an information technology equipment room as defined in NFPA 75, Standard for the Protection of Electronic Computer/Data Processing Equipment.

Laboratory instruments communicating through coaxial cable networks.

Other susceptible computer and electronic loads as identified in “functional and operational requirements” or design criteria.

Isolated-ground power systems are not typically required for office PCs that communicate over unshielded twisted pair cables (e.g. Cat 6A) or fiber-optic cables.

- Connect 120V and 208V computer loads in large raised floor computer rooms to isolated-ground, separately derived 208Y/120V systems using power distribution units served by dedicated feeders if the service is either 480Y/277V or 208Y/120V.
- Configure the low-voltage distribution system to facilitate safe work practices during maintenance and alterations and to maximize power quality.
- Connect large motor and power loads to separate services or feeders from sensitive loads.
- Provide a separate feeder for each panelboard; do not tap panelboards from a feeder riser.
- Configure system to minimize power interruptions during modifications and maintenance.

### **Load Analysis & Building Main Service-Entrance Rating**

Submit preliminary load analysis summaries for initial review at the 100% Design Development (DD) milestone.

Prepare separate summaries for the normal and standby/emergency loads in similar format and present both summaries on the “General Information” sheet *and* the electrical one-line diagram in the drawing set.

Include in the load analysis summaries all anticipated connected loads by load type (e.g., lighting, receptacles, motors, computers/electronics, etc.) and duty (continuous and non-continuous), the corresponding demand factor, and the resulting total connected design

load for the project computed in accordance with NEC 220.

Include additional calculation results in each load analysis as follows:

Normal Power

- The estimated size and quantity of service-entrance conductors to supply the building load and the estimated minimum rating/setting of the service disconnecting means in accordance with NEC 230.42(A).
- The estimated service transformer base kVA rating and type (e.g., outdoor mineral-oil-filled or indoor dry-type) to supply the building based on the IEEE methodology described under the “Medium-Voltage Transformers” section of this Division (see sub-heading “Transformer Capacity”).

Include the anticipated future load growth factor (typically 20% for new buildings) in the estimate for the service transformer size.

Standby / Emergency Power

- The estimated kVA/kW output rating of the emergency power supply (e.g., outdoor diesel generator or indoor central battery inverter system) to supply all anticipated critical equipment and systems.

Submit updated load analysis summaries at each subsequent design review milestone during the Construction Documents phase as the building loads become better defined throughout the design process.

A sample load analysis summary for normal power and emergency power in the format and detail expected for the 100% CD review submission follows.

**Design Criteria**  
**Division 26 – Electrical**

**ELECTRICAL LOAD ANALYSIS SUMMARY – NORMAL POWER**

| PRIMARY NOMINAL SYSTEM VOLTAGE:   | 12.47 kV, 3-PHASE, 3-WIRE Δ (LOW-IMPEDANCE GROUNDED NEUTRAL) |                        |                    |                  |                          |
|---|--|------------------------|--------------------|------------------|--------------------------|
| SECONDARY NOMINAL SYSTEM VOLTAGE:   | 480Y / 277V, 3-PHASE, 4-WIRE                                 |                        |                    |                  |                          |
| DESIGN POWER FACTOR WITH CORRECTION:  | 0.97 OR 97%  |                        |                    |                  |                          |
| DESCRIPTION OF LOAD   | CONNECTED LOAD (kVA)   | LOAD DUTY <sup>2</sup> | LOAD DEMAND FACTOR |                  | DESIGN LOAD <sup>1</sup> |
|   |  |                        | NEC REF.           | MULTIPLIER       |                          |
| LIGHTING  | 190  | CD                     | 230.42(A)(1)       | 1.25             | 238                      |
| GENERAL POWER / RECEPTACLES   | 510  | NC                     | 220.44             | N/A <sup>3</sup> | 260                      |
| COMPUTERS / ELECTRONIC POWER  | 450  | NC                     |                    | 1.00             | 450                      |
| MOTORS  | 927  | NC                     | 430.24             | 1.00             | 927                      |
| FIRE PUMP (100 HP)  | 100  | NC                     |                    | 1.00             | 100                      |
|   |  |                        |                    |                  | 0                        |
| SUBTOTAL - TOTAL CONNECTED LOAD (TCL)   | 2,177  | -                      | -                  | -                | 1,975                    |
| FUTURE LOAD GROWTH (FLG) AT 20% OF TCL <sup>4</sup>   | -  | -                      | -                  | -                | 395                      |
| TOTAL DESIGN DEMAND/LOAD (TDL)  | -  | -                      | -                  | -                | 2,369                    |
| FULL LOAD CURRENT OF SERVICE AT 480V, 3-PHASE   | -  | -                      | -                  | -                | 2,850                    |
| SERVICE CONDUCTOR SIZE & QUANTITY <sup>5</sup>  |  |                        |                    |                  | --                       |
| SWBD MAIN CIRCUIT BREAKER SETTING <sup>6</sup>  | -  | -                      | -                  | -                | 2850 / 3000              |
| SERVICE TRANSFORMER PEAK LOAD FACTOR <sup>7</sup>   | -  | -                      | -                  | -                | 1.82                     |
| MINIMUM TRANSFORMER NAMEPLATE CAPACITY  | -  | -                      | -                  | -                | 1302                     |
| STANDARD kVA TRANSFORMER RATING (55 / 65°C)   | -  | -                      | -                  | -                | 1,500                    |
| NOTES:  |  |                        |                    |                  |                          |
| <sup>1</sup> ALL LOADS ARE IN KILOVOLT-AMPERES (kVA)  |  |                        |                    |                  |                          |
| <sup>2</sup> DEFINITION OF "LOAD DUTY" PER NEC 100 DEFINITION OF "CONTINUOUS LOAD": A LOAD THAT IS EXPECTED TO OPERATE AT ITS MAXIMUM CURRENT FOR A CONTINUOUS PERIOD OF 3 HOURS OR MORE. CD = CONTINUOUS DUTY, NC = NON-CONTINUOUS DUTY  |  |                        |                    |                  |                          |
| <sup>3</sup> 10kVA OR LESS AT DF OF 1.00 + REMAINDER OVER 10kVA AT DF OF 0.5.   |  |                        |                    |                  |                          |
| <sup>4</sup> FLG IS BASED ON AN AVERAGE ANNUAL INCREASE OF 1% FOR A NEW BUILDING OVER A 20-YEAR LIFE.   |  |                        |                    |                  |                          |
| <sup>5</sup> SIZE FOR MULTIPLE SETS OF PARALLEL SINGLE COPPER CONDUCTORS INSTALLED IN CONCRETE-ENCASED DUCTBANKS...BASED ON THE LOWER OF THE TWO AMPACITIES DERIVED FROM TABLE 310.16 AND ANNEX TABLE B310.7 ASSUMING A 75°C CONDUCTOR TEMPERATURE...FOR COPPER... [APPLY NEHER / McGRATH? FORMULA UNDER ENGINEERING SUPERVISION IN ACCORDANCE WITH NEC 310.15] |  |                        |                    |                  |                          |
| <sup>6</sup> BREAKER IS 100%...[SEE NEC VERBIAGE]   |  |                        |                    |                  |                          |
| <sup>7</sup> DETERMINE CAPACITY FOR AN OUTDOOR MINERAL OIL-FILLED PADMOUNTED ACCORDING TO THE METHODOLOGY DESCRIBED IN IEEE C57.92-1981 FOR TRANSFORMERS LARGER THAN 500kVA.  |  |                        |                    |                  |                          |

**Building Service-Entrance Equipment**

The electrical service-entrance equipment rating, dimensions, and location shall be determined concurrently with building space planning during the SD phase to ensure that sufficient space is provided in the appropriate locations throughout the building for electrical equipment rooms as described below.

Prepare and submit the following design documentation related to the project electrical load during the SD phase:

- The maximum main service-entrance equipment rating
- The maximum kVA rating of the service transformer
- The maximum connected life safety (emergency power) load

Locate the building service point and service equipment as close as practicable to the center of the load area. Refer to IEEE Std 141™, Chapter 3 for additional guidance. For A&M System facilities, use the following definitions for electric “utility” and “service” or “service point,” based on the configuration of the service system:

#### Service (or Utility) Transformer

The utility system includes the medium-voltage distribution system and the service transformer. The service point is at the low-voltage (120/240V, 208Y/120V, or 480Y/277V) terminals of the service (or utility) transformer.

#### Secondary Unit Substation

The utility system includes the medium-voltage distribution system, the unit substation medium-voltage switchgear, and the unit substation transformer. The service point is at the low-voltage terminals of the secondary unit substation transformer. The secondary unit substation may be inside or outside the building.

#### Overhead Low-Voltage Utility Service

The utility system includes the medium-voltage distribution system, the pole mounted transformer(s), and the low-voltage service drop. The service point is at the building service-entrance weather head (or equivalent).

#### Underground Low-Voltage Utility Service

The utility system includes the medium-voltage distribution system, the pole-mounted transformer(s), and the low-voltage underground service lateral. The service point is at the line terminals of the first low-voltage service disconnecting means. The low-voltage service disconnect may be located on the utility pole, outside the building, or inside the building.

#### **Main & Auxiliary Electrical Equipment Rooms**

Provide one Main Electrical Room on the ground floor to serve the building. Provide additional auxiliary electrical equipment rooms as required to distribute low-voltage power throughout the building in a cost-effective manner.

Electrical loads shall be served by panelboards and branch circuits located on the same floor.

*This requirement may necessitate providing at least one auxiliary electrical equipment room on each floor of the building, even if there is no other design reason to do so, such as minimizing circuit lengths between the source and its supply to limit voltage drop.*

Locate electrical equipment rooms in buildings as close to the center of the load as practicable.

Locate in electrical equipment rooms all electrical switchgear, switchboards, panelboards, dry-type transformers, transfer switches, lighting contactors, and similar electrical equipment associated with the supply or distribution of low-voltage power from a centralized location. Exceptions include one or more of the following conditions:

Equipment that is required by code to be located at or within sight from the load(s) it serves.

Equipment that may be more cost-effectively placed near the load(s) it serves if that location also facilitates the operation and/or maintenance of the equipment it serves.

Motor control centers, motor controllers, disconnect switches and panelboards that serve mechanical equipment located in a room designated for HVAC equipment and/or pumps may be located inside a mechanical equipment room.

Variable frequency drives may be located in mechanical equipment rooms only if the rooms are fully air-conditioned.

A panelboard serving a laboratory may be located in the laboratory space or in a corridor where the panelboard:

- Is located within 10 ft. of the door.
- Serves only equipment inside the laboratory.
- Contains signage on the exterior front cover clearly identifying the laboratory room[s] it supplies.

Size all electrical equipment rooms to accommodate the required electrical equipment plus future growth anticipated by the User.

Minimum floor dimensions of auxiliary electrical equipment rooms: 8 ft by 10 ft.

Minimum floor dimensions of Main Electrical Room: None. The room dimensions shall be established to accommodate the anticipated size of the service-entrance equipment and other electrical equipment to be located in the room

Refer to “General Information,” “Building Core Elements” in Section A of the Design Criteria for associated with main and auxiliary electrical equipment rooms.

### **Electricity Metering**

Provide digital metering of electricity use for all buildings on the secondary side of the service transformer at the main service-entrance equipment.

Provide digital sub-metering of electricity use for specific operations, activities, building/facility systems and/or equipment in accordance with User requirements.

TAMUS has selected the ION 8600 Series digital meter manufactured by Square D Company as the sole manufacturer of its standard main meter and sub-metering system at all TAMUS campuses to ensure complete compatibility of the remote communications interface among all campuses.

### **Low-Voltage Power Factor Correction**

The A/E shall design the electrical power system such that it operates at a 95 to 97% lagging power factor during peak estimated demand load conditions. The power factor shall not become leading under minimum load conditions.

### **Surge Protection for Low-Voltage Distribution**

- Provide a transient-voltage surge-suppression (TVSS) device and high-frequency filter system for the main electrical service-entrance equipment and all panelboards that serve computers and other non-linear, high-harmonics loads.
- Provide an IEEE C62.41.2 Location Category C-High, UL 1449 Type 1, secondary surge arrester (SSA) on the line side of the service-entrance disconnecting means in electrical service-entrance equipment to protect each ungrounded conductor.
- Provide an IEEE C62.41.2 Location Category C-Low, UL 1449 Type 1, rated SSA to protect each ungrounded conductor of each power circuit that exits the structure to serve detached equipment or structures and extends more than 100 ft and is not installed underground or in metallic raceway.
- Provide UL 497B listed surge protective device for each signal, data, control, and alarm service circuit that enters the structure.
- Provide UL 497B listed surge protective device for each signal, data, control, and alarm circuit that exits the structure to serve detached equipment or structures and extends more than 100 ft and is not installed underground or in metallic raceway. Where such circuits are longer than 100 ft install UL 497B listed surge protective device at both ends of the circuit.

- Provide UL 497C listed coaxial surge protective device for each antenna and coaxial cable service line that enters the structure.
- Provide UL 497C listed surge protective device for each coaxial cable circuit that exits the structure to serve detached equipment or structures and extends more than 100 ft and is not installed underground or in metallic raceway. Where such coaxial cable circuits are longer than 100 ft install UL 497C listed surge protective device at both ends of the circuit.

Provide an IEEE C62.41.2 Location Category C-Low, UL 1449 Type 2, transient voltage surge suppressor (TVSS) in the service equipment to protect each ungrounded conductor on the load side of the service-entrance disconnecting means.

Provide an IEEE C62.41.2 Location Category B, UL 1449 Type 2, TVSS in branch circuit panelboards serving instrument or computer loads to protect each ungrounded conductor.

Design surge protection installation to comply with requirements in NFPA 780 and the *NEC*<sup>®</sup>.

### **Low-Voltage Switchgear, Switchboards, & Power Panelboards**

#### **Design Guidance**

Consider the following guidance for selecting the main service equipment (low-voltage switchgear, switchboards, or power panelboards) to cost-effectively serve the loads.

- Mains greater than 1200A main lugs or 800A frame size main circuit breaker but all feeder circuit breakers smaller than 800A frame size:

Select a deadfront distribution switchboard in compliance with NEMA PB 2 with branch and feeder circuit breakers panel-mounted. For a main circuit breaker with a weight exceeding 42 lbs., specify a draw-out mounted circuit breaker with an RMS-sensing solid-state trip unit. Some manufacturers offer fixed-mounted 1200A frame-size electronic trip circuit breakers that weigh less than 42 lbs.

- Any feeder circuit breaker 800A frame size or larger with a weight exceeding 42 lbs.:

Select low-voltage metal-enclosed power circuit breaker (draw-out) switchgear, constructed according to IEEE C37.20.1 – *Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear*, with a track-mounted hoist. Specify circuit breakers with RMS-sensing solid-state trip units.

Distribute low-voltage power from one or more circuit breaker-type switchgear assemblies, switchboards, or power panelboards located in dedicated electrical equipment rooms.

For service-entrance equipment, use low-voltage switchgear, switchboards, or power panelboards that comply with *NEC*<sup>®</sup> requirements for service-entrance equipment, have a single main circuit breaker, and are NRTL-labeled for service-entrance use.

Select low-voltage distribution system switchgear, switchboards, or power panelboards to cost-effectively serve the loads. Use the following criteria for selecting equipment.

- Mains equal to or less than 1200A main lugs or 800A frame size main circuit breaker:

NEMA PB-1, UL 67 front accessible power panelboard, front and rear aligned, branch and feeder circuit breakers panel mounted.

- Mains greater than 1200A main lugs or 800A frame size main circuit breaker but all feeder circuit breakers smaller than 800A frame size:

NEMA PB-2 switchboard with branch and feeder circuit breakers panel-mounted. For a main circuit breaker with a weight exceeding 42 lbs., use a draw-out mounted circuit breaker with RMS sensing solid-state trip unit. *Some manufacturers offer fixed-mounted 1200A frame-size electronic trip circuit breakers that weigh less than 42 lbs.*

- Any feeder circuit breaker 800A frame size or larger with a weight exceeding 42 lbs.:

IEEE C37.20.1 low-voltage metal-enclosed power circuit breaker (draw-out) switchgear with a track-mounted hoist. Use circuit breakers with RMS sensing solid-state trip units.

Provide enclosures suitable for the locations where the equipment will be installed. Provide door-in-door fronts for indoor power panelboards.

Provide working ample space behind rear-accessible switchgear, switchboards, and panelboards in compliance with the minimum clearances required by the *NEC*<sup>®</sup>. Provide additional space in these areas to facilitate examination of the equipment by campus Physical Plant maintenance personnel. The procedure and equipment used at each campus may vary; therefore, contact the University's Physical Plant supervisor to obtain information on the additional working space required for the type, configuration, and size of the equipment to be installed.

Locate panelboards as close to the center of the load area and on the same floor as the branch circuit loads served to meet the following criteria:

- Maximum branch-circuit voltage drop: 3.0%
- Maximum 208Y/120V system branch circuit length: 100 ft



**Design Criteria**  
**Division 26 – Electrical**

- Maximum 480Y/277V system branch circuit length: 230 ft

Where more than 50% of the panelboard connected branch circuit load is 3<sup>rd</sup> third harmonic-generating line-to-neutral connected equipment, such as PCs and monitors, provide panelboard with a 200% rated neutral bus.

Arrange the single-phase loads between all phases of each panelboard to obtain phase currents balanced to within 15 percent of the average of the phase currents.

**PANEL SCHEDULE 208V-3 PHASE-30CKT**

| POWER PANEL "PP2" MAINS: 100 AMP MAIN LUGS VOLTAGE:<br>208Y/120V, 3 PH, 4 W. SHORT CIRCUIT RATING: 8250 AMPS, RMS,<br>SYMMETRICAL LOCATION: TA-3-410-120 MOUNTING: SURF SECT. 1<br>SERVED BY: 3-410 XFMR2<br>LOCATION: TA-3-410-123   |        |       |       |       |     |         |     |         |       |         |        |                         |
|---|--------|-------|-------|-------|-----|---------|-----|---------|-------|---------|--------|-------------------------|
| SERVES  | C/B    | CONT  | RCPT  | PWR   | CKT | PH      | CKT | CONT    | RCPT  | PWR     | C/B    | SERVES                  |
| RCPT RM 101   | 20 / 1 |       | 1,440 |       | 1   | -A----  | 2   |         | 1,440 |         | 20 / 1 | RCPT RM 102             |
| RCPT RM 103   | 20 / 1 |       | 1,440 |       | 3   | ---B--  | 4   |         | 1,440 |         | 20 / 1 | RCPT RM 104             |
| RCPT RM 105   | 20 / 1 |       | 1,440 |       | 5   | ----C   | 6   |         | 1,440 |         | 20 / 1 | RCPT RM 106, 108        |
| RCPT RM 107   | 20 / 1 |       | 1,440 |       | 7   | -A----  | 8   |         | 1,440 |         | 20 / 1 | RCPT RM 110             |
| RCPT RM 109   | 20 / 1 |       | 1,440 |       | 9   | ---B--  | 10  |         | 1,440 |         | 20 / 1 | RCPT RM 112             |
| RCPT RM 111   | 20 / 1 |       | 1,440 |       | 11  | ----C   | 12  |         | 1,440 |         | 20 / 1 | RCPT RM 114             |
| VACUUM PUMP RM 111  | 20 / 3 |       |       | 440   | 13  | -A----  | 14  |         |       | 1,000   | 20 / 3 | OUTLET FOR LASER RM 114 |
|   |        |       |       | 440   | 15  | ---B--  | 16  |         |       | 1,000   |        |                         |
|   |        |       |       | 440   | 17  | ----C   | 18  |         |       | 1,000   |        |                         |
| LIGHTS RM 113   | 20 / 1 | 1,200 |       |       | 19  | -A----  | 20  |         | 1,440 |         | 1P20   | RCPT RM 113             |
| WELDER OUTLET   | 30 / 2 |       |       | 1,800 | 21  | ---B--  | 22  |         | 1,440 |         | 1P20   | RCPT RM 100             |
| RM 113  |        |       |       | 1,800 | 23  | ----C   | 24  |         | 1,440 |         | 1P20   | RCPT RM 115             |
| SPARE   | 20 / 1 |       |       |       | 25  | -A----  | 26  |         |       |         | 1P20   | SPARE                   |
| SPARE   | 20 / 1 |       |       |       | 27  | ---B--  | 28  |         |       |         | 1P20   | SPARE                   |
| SPARE   | 20 / 1 |       |       |       | 29  | ----C   | 30  |         |       |         | 1P20   | SPACE                   |
| TOTAL CONNECTED PHASE VOLT AMPERES:   |        |       |       |       |     | CALC A: |     | CALC B: |       | CALC C: |        |                         |
| CONNECTED: DESIGN: CONTINUOUS LOAD (CONT): 1200 VA CONTINUOUS LOAD @ 125%: 1500 VA RECEPTACLE LOAD (RCPT): 21600 VA RECEPT. LOAD PER NEC 220-13: 15800 VA NON-CONT. POWER LOAD (PWR): 7920 VA POWER LOAD @ 100%: 7920 VA 20% SPARE CAPACITY: 5044 VA TOTAL CONNECTED LOAD: 30720 VA TOTAL DESIGN LOAD: 30264 VA 85.3 AMPS 84.1 AMPS |        |       |       |       |     |         |     |         |       |         |        |                         |

## Low-Voltage Dry-Type Transformers

### General-Purpose Dry-Type Transformers

Use dry-type transformers as described below to derive system voltages for general-purpose loads where the switched-mode power supply load is less than 20% of the total connected load.

Where the average daily load will be less than 50% of the transformer nameplate rating use an ENERGY STAR labeled transformer that complies with NEMA TP-

*Guide for Determining Energy Efficiency for Distribution Transformers. ENERGY STAR labeled transformers will typically be used for loads in office buildings and similar occupancies.*

Where the average daily load will be 50% or more of the transformer nameplate rating use a low temperature rise dry-type transformer (115 °C rise or less). *Low temperature rise transformers will typically be used for process loads in laboratory buildings.*

### Transformer Loading

Provide each transformer with a percentage of spare capacity not less than the percentage of future electrical load growth specified under the section “Load Analysis & Building Main Service-Entrance Rating” in this Division.

Including the spare capacity described above, load transformers to no more than 97.5 percent of the sea-level nameplate rating when used in an environment where the average ambient temperature for any 24-hour period does not exceed 86 °F (30 °C), and the maximum cooling air temperature during the 24-hour period does not exceed 104 °F (40 °C).

Transformers may be operated at nameplate rating where there is sufficient ventilation or mechanical cooling to maintain an average ambient temperature less than 83.3 °F (28.5 °C). The 83.3 °F average ambient temperature shall cover 24 hours, and the maximum cooling air temperature during the 24-hour period shall not exceed 92.75 °F (33.75 °C).

Where it is not possible to provide the average 86 °F ambient temperature, de-rate dry-type transformer kVA capacity in accordance with ANSI/IEEE C57.96, Table 1.

### **Grounding & Bonding for Low-Voltage Distribution**

Provide low-resistance ground fields for computers and other electronic equipment in accordance with applicable codes and standards.

Provide a grounding riser diagram that shows the interconnection of all grounded and

ground connectors to ground rods and the counterpoise system.

Install the grounding systems in accordance with *NEC*<sup>®</sup> Article 250, IEEE Std. 142<sup>™</sup>, IEEE Std 1100<sup>™</sup>,

### Grounding Electrode System

Install the grounding electrode systems having calculated ground resistances not exceeding the following values:

Aggregate service rated 50 kVA and less: As required by the *NEC*<sup>®</sup>.

Aggregate service rated more than 50 kVA but less than 2500 kVA: 5 ohms

Aggregate service rated 2500 kVA and larger: 1 ohm

Perform calculations of grounding electrode resistance using methods outlined in IEEE Std. 142<sup>™</sup>.

*Since soil resistivity at the various A&M System-Member campuses varies widely, the A/E shall investigate and determine the soil resistivity for each project site. A recommended method is to have soil resistivity measured during the geotechnical survey and to include it in the geotechnical report, using the Wenner four-electrode method and procedures described in ASTM G57.*

For new structures install a concrete-encased main grounding electrode in the lower part of the perimeter strip footing or grade beam to form a complete loop around the building. Use one of the following materials for the electrode:

(1) A bare copper ground cable not smaller than the grounding electrode conductor required in the *NEC*<sup>®</sup> and not smaller than 4 AWG.

(2) A bare or galvanized perimeter concrete reinforcing bars that are made electrically continuous. Use reinforcing bars not smaller than the following, based on the total length of the interconnected and paralleled reinforcing bars as follows:

Total length of reinforcing bars Minimum reinforcing bar 112 ft 1 3/8" (#11 bar) 150 ft 1" (#8 bar) 192 ft 3/4" (#6 bar) ft 5/8" (#5 bar) 268 ft 1/2" (#4 bar)

Interconnect reinforcing bars using bare copper jumpers that are either exothermically welded to the reinforcing bars or connected using hydraulically compressed tap fittings that meet requirements of IEEE 837, *Standard for Qualifying Permanent Connections Used in Substation Grounding*. Use jumpers that are neither smaller than the required *NEC*<sup>®</sup> grounding electrode conductor nor smaller than 4 AWG.

For new structures bond each perimeter structural steel column to the main grounding electrode described above.

Use bond conductors that are not smaller than the grounding electrode conductor required in the *NEC*<sup>®</sup> and not smaller than 4 AWG.

Make bonding connection to either directly to the steel column or a column anchor bolt using either an exothermic weld or a hydraulically compressed fitting that meets IEEE 837 requirements.

For modifications to existing structures measure the ground resistance of the existing main grounding electrode and verify that the electrode system is adequate and substantial.

Verify that the main grounding electrode is a separate electrode from that used for lightning protection.

Use bare or galvanized perimeter concrete reinforcing bars that are made electrically continuous. Use reinforcing bars not smaller than the following based on the total length of the interconnected and paralleled reinforcing bars:

Install one or more of the following supplemental grounding electrode(s) to obtain the required ground resistance or to establish a main grounding electrode that is separate from the lightning protection ground:

A bare copper ground cable not smaller than the grounding electrode conductor required in the *NEC*<sup>®</sup> and not smaller than 2 AWG, not less than 20 feet long, and buried not less than 30 inches deep adjacent to the building foundation in a Bentonite<sup>132</sup> slurry backfill.

One or more electrolytic ground rods installed in accordance with the manufacturer's instructions.

A bare copper ground cable, not smaller than the grounding electrode conductor required in the *NEC*<sup>®</sup> and not smaller than 4 AWG, not less than 20 ft long where outside the building perimeter, and enclosed in the concrete envelope for the underground electrical service conduit(s).

Install a main grounding electrode bar adjacent to the service-entrance equipment; use the main grounding electrode bar as a point for bonding all grounding electrodes, power systems, separately derived systems, communications systems, piping systems, and structural steel.

Connect the grounding electrode bar to the main grounding electrode using unspliced copper cable and irreversible connections. Irreversible connections are either exothermic welds or IEEE Std. 837 compression lugs attached with tamper-proof nuts and bolts.

Install main grounding electrode bar extensions at additional locations in reinforced concrete structures for grounding separately derived systems that are remote (more than 50 ft) from the main grounding electrode bar. Establish main grounding electrode bar extensions by installing ground bars connected to the main ground electrode bar using unspliced 4/0 AWG copper cable with irreversible connections.

Connections to the main grounding electrode bar (or extensions) will be considered direct connections to the main grounding electrode.

Label each connection to the main grounding electrode bar or extensions.

Bond building structural steel, interior metallic piping systems, and exterior metal water piping systems to the main grounding electrode bar using copper cable, listed pipe clamps, exothermic welds, and compression lugs that meet requirements of IEEE Std 837. Use bonding conductors that are not smaller than the grounding electrode conductor required in the *NEC*<sup>®</sup> and not smaller than 4 AWG.

Bond the lightning protection grounding counterpoise to the building grounding electrode system at the main grounding electrode bar using 600V insulated 4/0 AWG ground cable and compression lugs that meet IEEE Std 837 requirements.

#### Circuit and System Grounding

Connect the service-entrance equipment ground bus to the main grounding electrode bar with unspliced grounding conductor sized per *NEC*<sup>®</sup> Table 250.66.

In the service-entrance equipment, connect the system grounded conductor bus to the equipment ground bus with a bonding jumper sized per *NEC*<sup>®</sup> Table 250.66; do not use a factory furnished bonding screw.

Separately Derived Systems (transformers, generators, computer power distribution units, UPSs, etc.):

Ground separately derived systems in the vicinity (within 50 ft) of the main electrical room to the main grounding electrode bar.

Ground separately derived systems remote from the main electrical room to the nearest effectively grounded building structural steel or metal water pipe within 5 ft of the point of entrance into the building. If neither grounding electrode is available, install a main grounding electrode bar extension near the separately derived system disconnecting means.

Connections to the main grounding electrode bar (or extensions) will be considered direct connections to the main grounding electrode.

In addition to the equipment ground bar, install an insulated isolated ground bar in switchboards and panelboards supplying isolated ground circuits.

At the first isolated ground system phase conductor overcurrent device or disconnecting means, bond the isolated ground bus to the equipment ground bus with a bonding jumper sized per *NEC*<sup>®</sup> Table 250.66; do not use a factory furnished bonding strap or bonding screw. Make no other isolated ground to equipment ground connections.

In addition to the equipment-grounding conductor, install a dedicated 600-volt insulated (green/yellow) isolated ground conductor for each isolated ground feeder.

Connect the isolated ground conductors to the isolated ground bars in switchboards and panelboards.

### **Raceway Systems for Low-Voltage Conductors**

Use raceway systems to contain low-voltage service and feeder wiring systems.

Design raceway systems with consideration given to all conductor adjustment factors required by the *NEC*<sup>®</sup>.

Design raceway systems for low-voltage conductors so calculated installation pulling tension and sidewall pressure will not exceed the following values:

Cable tension:

- 0.008 lb./cmil for up to 3 conductors, not to exceed 10,000 pounds.
- 0.0064 lb./cmil for more than 3 conductors, not to exceed 10,000 pounds.
- 1000 lbs. per basket grip.

Sidewall pressure: 500 lbs./ft.

Guidance: Conduit runs within the following limits of bends and conduit length between pull points will not exceed the above installation pulling tension and sidewall pressure limits:

Three (3) equivalent 90-degree bends: not more than fifty feet (50') between pull points,

Two (2) equivalent 90-degree bends: not more than one hundred feet (100') between pull points,

One (1) equivalent 90-degree bends: not more than one hundred fifty feet (150') between pull points,

Straight pull: not more than two hundred feet (200') between pull points.

Indicate sizes of conduits, wireway sections, and cable tray sections on the construction or record as-built drawings.

Provide concrete-encasement and warning tape for underground low-voltage service and feeder conduit outside the perimeter of the building. Provide warning tape for underground low-voltage service and feeder conduit inside the perimeter of the building. Provide not less than 7.5 inches center-to-center separation of conduits. Provide not less than 3 inches concrete coverage on all sides. *Guidance: Low-voltage service and feeder conduits inside the perimeter of the building need not be concrete-encased.*

### Low-Voltage Conductors

Identify all wiring system conductors at each accessible location using color-coding that is consistent throughout the building. Refer to the table below for standard color-coding of wiring according to system operating voltage level.

*Note: For minor work in existing facilities use wiring color codes that match existing color codes so long as NEC® requirements for identifying grounded and grounding conductors are satisfied.*

| Color Code for Low-Voltage Conductors   |                              |                               |                               |
|---|------------------------------|-------------------------------|-------------------------------|
| Line  | System Operating Voltage     |                               |                               |
|   | 240 / 120V<br>1-phase/4-wire | 208Y / 120V<br>3-phase/4-wire | 480Y / 277V<br>3-phase/4-wire |
| Phase A or Line 1   | Black                        | Black                         | Brown                         |
| Phase B or Line 2   | Red                          | Red                           | Purple                        |
| Phase C or Line 3   | N/A                          | Blue                          | Yellow                        |
| Neutral   | White                        | White                         | Gray                          |
| Equipment Ground  | Green                        | Green                         | Green                         |
| Isolated Ground   | N/A                          | Green / Yellow Stripe         | Green / Yellow Stripe         |
| Switched Leg  | Black                        | Pink                          | Pink                          |
| High Leg <sup>1</sup>   | N/A                          | Orange                        | Orange                        |
| Notes:  |                              |                               |                               |
| <sup>1</sup> Applies only to a 4-wire, delta-connected system where the midpoint of one phase winding is grounded. Refer to NEC Articles 110.15 and 408.3(F). |                              |                               |                               |

## Conductors & Cables

### Wiring Color Codes

Identify all branch circuit conductors (phase, grounded, and grounding conductors) using color-coding that is consistent throughout the building. *For minor work in existing facilities use wiring color codes that match existing color codes so long as NEC® requirements for identifying grounded and grounding conductors are met.*

### **Building Wire and Cable**

Use copper conductors that have been sized with consideration to adjustment factors for voltage drop, ambient temperature, raceway fill, harmonics, and future loading.

Indicate the number and size of conductors in conduit runs, wireway sections, and cable tray sections on the design drawings and any changes on the record as-built drawings.

Use copper conductors for branch circuit wiring. Aluminum is not acceptable.

Use minimum No. 12 AWG for branch circuit wiring.

Design branch circuit conductors for 3 percent maximum voltage drop at full-design load. Use voltage drop calculation methods outlined in Chapter 3 of IEEE Std 141.

Do not use “multi-wire” branch circuits. Provide a dedicated grounded (neutral) conductor for each branch circuit that requires a neutral.

### **Lighting & Branch Circuit Wiring**

#### **Raceways & Boxes**

Use raceway systems to contain premises wiring systems.

Size raceways considering all conductor adjustment factors required by the NEC.

Indicate sizes of branch circuit conduits and wire way sections on the design drawings and any changes on the record as-built drawings.

In addition to locations required by the NEC, provide conduit-sealing fittings with approved sealant at the following locations:

- Where conduits cross the boundary of a radiological area.
- Where conduits pass between areas where air pressure differential must be maintained.
- Where conduits enter an enclosure protected by a clean agent total flooding fire suppression system.

Use surface metal raceway where there is a high density of receptacle outlets such as at laboratory benches and in computer server rooms. Use surface metal raceway with internal divider(s) to contain power and telecommunications distribution.

Use surface metal raceway in accordance with the NRTL listing for the product.



Use base, covers, and fittings designed by the manufacturer to be assembled together.

Only NRTL-listed, fixed multi-outlet assemblies may have the branch circuit loads calculated based on NEC, Section 220.14(H).

Raceways, boxes and fittings used under raised floors (e.g., computer rooms, server rooms) must have low flame spread, low smoke, and zero halogen characteristics determined in accordance with ASTM E 162 – *Standard Test method for Surface Flammability of Materials Using a Radiant Heat Source*, ASTM E 662 – *Standard Test Method for Optical Density of Smoke Generated by Solid Materials*, or Bombardier SMP-800C- *Toxic Gas Generation*.

### **Flexible Conduit**

Use flexible metal conduit for connections to vibrating or moving equipment; use liquid-tight flexible metal conduit for such connections in damp or wet locations or where deteriorating agents may be present such as in some parts of mechanical rooms. Minimum length shall be 18 inches, maximum length per the NEC.

### **Boxes**

Provide complete system of outlet boxes, junction boxes, and pull boxes that meet requirements of the *NEC*<sup>®</sup> and are compatible with all other related systems.

Coordinate locations of outlet boxes with furniture and equipment.

Design the branch circuit distribution system for office buildings using a modular grid of junction boxes containing the “homerun” circuits for lighting, general-power, and isolated-ground power systems to allow partition walls to be added or removed with a minimum of interruption of service to existing outlets.

## **Wiring Devices & Connections**

Specific electrical requirements for all outlets and equipment connections listed in the Requested Facilities section of the POR will be determined by the Project A/E in consultation with the University’s User Coordinator and Physical Plant Department Electrical Supervisor.

Provide outlets in all spaces in accordance with the NEC and for fixed and movable equipment listed in the POR. Provide exterior outlets as required for grounds maintenance.

Electrical outlets should be distributed throughout the building. However, the requested flexibility will require particular consideration for placement, especially of special-

purpose outlets.

All branch-circuits serving computer loads shall originate from a computer-grade panelboard.

Provide receptacle outlets at locations required and in sufficient density to minimize or eliminate the use of extension cords, re-locatable power taps, and outlet strips.

Show receptacle outlets on the design drawings and any changes on the as-built drawings.

Provide 120-volt, 15- or 20-ampere general-purpose duplex receptacle outlets connected to 20-ampere circuits at the locations described below, at locations required by the NEC, and at locations dictated by the User's functional and operational requirements. Design distribution system using a unit load of 180 VA per general-purpose receptacle strap unless noted otherwise.

Hard wall enclosed offices, conference rooms, copy rooms, laboratories, and similar spaces: One outlet on each wall plus additional outlets so no point measured horizontally in any wall space is more than 6 ft from a general-purpose receptacle outlet.

Open-office workstations: At least two outlets plus additional outlets so no point measured horizontally in any wall panel space where equipment may be located is more than 6 ft from a general-purpose receptacle outlet.

Laboratory countertops: At least one outlet for each 3 ft of countertop.

Kitchens and break rooms: At least one outlet on each wall where not used for counters.

Equipment rooms: At least one outlet plus additional receptacle outlets so all equipment that may require maintenance is within 25 ft of a receptacle. *See requirement below for GFCI receptacles in mechanical equipment rooms.*

Corridors: 20-ampere receptacle outlets on dedicated circuit(s) for custodial use located so no point on any corridor floor is more than 25 ft from an outlet.

Copy rooms: One outlet on each wall plus additional outlets so no point measured horizontally in any wall space is more than 6 ft from a general-purpose receptacle outlet. At least one outlet for each 3 ft of countertop or fraction thereof for small office equipment such as FAX machines and printers. At least one 20 ampere receptacle on an individual circuit for a copy machine. *Some copy rooms may have high-capacity printers requiring higher-capacity circuits.*

Provide 120-volt, 15 or 20-ampere, double-duplex PC receptacle outlets connected to dedicated circuits at the locations described below and at locations dictated by the User's functional and operational requirements to serve PCs, monitors, and printers:

Hard wall enclosed offices: At least two outlets located on opposite walls.

Open-office workstations or cubicles: At least one outlet.

Laboratories: At least one outlet.

Conference rooms: At least one outlet located at the front of the room. At least one floor outlet located centered under the conference table for audio-visual and teleconferencing equipment.

Mechanical rooms: At least one outlet in each mechanical room for building automation system equipment.

## **Motors & Motor Controllers**

### **Electric Motors**

Definite-purpose inverter-Fed motors shall meet the requirements of NEMA, MG-1, Section IV, Part 31.

All other motors shall meet the requirements of NEMA, MG-1.

All motors shall meet the energy efficiency requirements of the *Texas State Energy Conservation Design Standards for New State Buildings* and shall meet or exceed the applicable portions of the *NEC*<sup>®</sup> and Underwriters Laboratories, Inc.

### **Variable Frequency Drives (VFDs)**

Provide variable frequency drives (VFDs) for 3-phase motors rated at 5 HP and larger.

VFDs shall conform to the requirements of IEEE 519, *Recommended Practices and Requirements for Harmonic Control in Electrical; Power Systems*.

Specify VFDs with output filters of 3% impedance to reduce the frequency of motor failures.

VFDs that utilize pulse-width-modulation (PWM) and insulated-gate bipolar technology (IGBT) are preferred.

## **Grounding & Bonding**

### **Enclosure and Equipment Grounding**

Provide a 600-volt, insulated (green) equipment ground conductor in each branch circuit

raceway.

Install a 600-volt, insulated (green) equipment ground conductor in each raceway for line voltage control wiring and non-power-limited wiring systems. Size equipment-grounding conductors as required in the NEC.

An equipment-grounding conductor is not required in raceways for power limited alarm and telecommunications wiring systems; however, metallic raceways must be electrically continuous as required by the NEC.

### **Isolated Grounding System**

In addition to the equipment-grounding conductor, install a dedicated 600-volt insulated isolated grounding conductor with each isolated ground branch circuit. *The purpose of isolated grounding systems is to reduce common-mode noise in circuits serving sensitive electronic equipment.*

Use green insulation with a yellow stripe.

Make the isolated ground conductors the same size as circuit the phase conductors..

Connect the isolated ground conductors to the isolated ground bars in panelboards and to the isolated ground terminals at receptacles and equipment.

## **Interior Lighting**

### **General**

The lighting and day lighting systems of a building represent one of the most important aspects of building aesthetics. The performance of these systems has a direct effect on the functionality and energy efficiency of the illuminated spaces.

### **Design Criteria**

Design all lighting systems in accordance with applicable codes and standards.

Comply with the mandatory lighting requirements of the latest edition of ANSI/ASHRAE/IESNA Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings* for maximum allowable lighting power densities and lighting controls.

Illuminate all spaces in accordance with the User's requirements and the recommendations presented in the latest edition of the Illuminating Engineering Society of North America (IESNA) *Lighting Handbook*.

Design lighting systems to limit glare, minimize uniformity ratios, and provide CRIs appropriate to the functionality of the space. Refer to the IESNA *Lighting Handbook* for guidance.

Do not exceed a lumen depreciation of 5.0% in the calculation of design footcandles.

Design lighting systems to minimize the maintenance required.

Do not specify incandescent lighting.

The specification of custom-designed luminaires is discouraged because of the special maintenance required.

Select a combination of direct/indirect energy-efficient fluorescent luminaires to light general interior spaces. Specify luminaires to be either recessed type or pendant-mounted.

Suspend all recessed 2' x 2' and 2' x 4' light luminaire from the building's ceiling structure by a minimum of two hanger wires, one attached to each diagonally-opposed corner of the luminaire housing.

Specify either type T8 or T5 linear, low-mercury fluorescent lamps with efficacies above 90 lumens/watt and a color temperature of either 3500K or 4100K for use throughout the building. Confirm the type with the electrical supervisor for that university's Physical Plant Department, if applicable.

All lamps shall have must have a color-rendering index (CRI) greater than or equal to 80. Minimum rated lamp life must be 20,000 hours.

All compact fluorescents lamps (CFL) must have a minimum efficacies of 60 lumens/watt and maximum lumen depreciation of 15%. Minimum rated lamp life must be 10,000 hours. Lamp color and CRI must be consistent with linear fluorescent lamps. No CFLs below 13W shall be used.

All ceramic metal halide lamps used in interior finished spaces shall have a color-rendering index (CRI) greater than 75.

All ballasts shall be UL-rated and CMB-certified, rapid-start electronic type with the following characteristics:

- Sound ratings: “A” for 430mA lamps, “B” for 800mA lamps, and “C” for 1500mA lamps.
- Operate at less than 10% total harmonic distortion (THD).

Instant-start ballasts shall not be used. Electronic ballasts shall have a Program start

ballasts are acceptable.

Where dimming is required, use fluorescent fixtures and electronic ballasts that are capable of dimming to 10% (minimum) of full light output.

### **Classroom Areas**

Widely varying illumination levels are necessary for various project types. Fluorescent fixtures shall be wired so that separate switches control banks of lights in rows (width wise) running from front to back of room.

The front row of lights can be turned off when the overhead or video project is used.

The next row of lights can be turned off during slide/filmstrip viewing, leaving the last switch to turn off last row of lights for opaque projection and 16mm projection. Thus, ambient light levels can be maintained as high as possible for visual comfort and note taking without compromising the quality of the project image.

Directionality and resultant glare on screens, TV monitors must be considered.

Lighting controls must be easily accessed by presenter and should be positioned at both the front and rear of room.

#### **Switching**

Provide multiple switching of interior lighting as required for flexibility and economy of operation.

Any exterior lights and site lighting will be controlled by the energy management system with a hand off auto switch override or by photocell.

### **Egress & Emergency Lighting**

Provide emergency lighting and exit lights as required.

Emergency lighting shall comply with current fire and safety codes.

Provide emergency lighting and marking of means of egress in accordance with the *National Electrical Code*, the *International Building Code*, and NFPA 101, the *Life Safety Code*®.

Perform lighting calculations using appropriate procedures as outlined in the *IESNA Lighting Handbook*.

## Exterior Lighting

Provide exterior lighting at entrances, pedestrian walkways, and other locations as required.

Use System approved site lighting fixtures and standards where appropriate. Owner must approve other site lighting fixtures.

## Standby/Emergency Power

Provide emergency power to areas and equipment required by regulation and guideline.

The A/E shall determine the full extent of emergency power needs with the User and FP&C System Electrical Engineer.

### Diesel-Engine-Driven Generator Sets

The Project A/E shall perform a code analysis and a life cycle cost economic evaluation of the source for emergency power to determine if an emergency generator is required.

Generator fuel type shall be consistent with other generator on the campus

Emergency generators shall be screened within a service yard.

Provide a fire barrier between service transformer and emergency generator if both units are located within a common area [indoors or outdoors].

Automatic transfer switch is required.

Provide a load bank if an emergency standby generator is required.

Generator testing shall be in accordance with NFPA 110.

If diesel powered provide an independently-mounted 24-hour double-walled diesel fuel tank.

Petroleum Products or Hazardous Chemical Storage Tanks:

Emergency generators which supply only life safety code required loads will be equipped with skid mounted fuel tanks sized to provide a 24 hour supply of fuel.

Generators supplying power to process type equipment may be furnished with A 60-hr. fuel supply.

Comply with the following requirements if an above-grade fuel storage tank is required:

Above-ground tanks shall not exceed 1100 gallons unless approved by the FPC Project Manager.

When required, design the [facility] to comply with the requirements of Texas Commission on Environmental Quality (TCEQ).

When an above-grade fuel storage tank is required the A/E is required to The storage tank subcontractor must have a valid certificate of registration and his installer or on-site supervisor must have a valid license issued by the Texas Water Commission.

Installation of storage tank is to be in accordance with accepted industry standard and manufacturers' recommendation.

Automatic tank gauging and low level alarm signal to EMS System and a high level alarm on a local horn or bell mounted at or near the tank vent approximately 8 ft. above grade.

Provide manhole, fill nozzle, level alarm and other nozzles as required.

Central Battery Inverter Systems (for emergency lighting only)

## **Campus-Specific Information**

### **Texas A&M University**

Medium-Voltage Relays: Manufactured by Schweitzer.

System Configuration: Campus express feeders may not be tapped for distribution to campus buildings.

### **Utility Metering**

This section covers requirements and information for the metering and remote monitoring of all utilities from the TAMU Utilities & Energy Management (UEM) Office, with the exception of the metering of electricity.

#### Electricity Metering at Service-Entrance & Sub-metering Levels

Digital metering of the electrical energy consumed by all buildings is typically required for every new building. Information and TAMU standard requirements for metering at the main incoming service (“service-entrance” or “service main”) and, if required by the User, the sub-metering level of the electrical distribution system, are addressed under



the heading “Electricity Metering” in the “Low-Voltage Service & Distribution” section of this Division. The remaining utilities for which metering is required include [domestic/potable] water, air, and gas.

Sub-metering: Digital meters Additional secondary digital meters shall be of the type manufactured by Square D and shall include a display, the size and type of the meter to be determined by the engineer.

Secondary meters shall be connected together with communications cable to allow for integration and communication with the main meter(s).

The main electric meter(s) shall include a separate Ethernet gateway

Each meter shall be installed per the manufactures specifications and shall be commissioned and integrated with the existing university metering system by a Square D employee during start-up.

This commissioning process shall be witnessed by UEM personnel.

The main secondary (service-entrance) electricity meter (s) shall be the ION 8600 Series manufactured by Square D. Contact the TAMU UEM (David Payne, PE, Manager for Distribution & Control; or Homer Bruner, Manager of Energy Management) to select the appropriate model within the ION 8600 Series, as the features and capabilities of the meter vary among several models within this series.

Additional secondary digital meters shall be of the type 850 series manufactured by Square D and shall include a display, the size and type of the meter to be determined by the engineer. Secondary meters shall be connected together with communications cable to allow for integration and communication with the main meter (s). The main electric meter (s) (8600B) shall include a separate Ethernet gateway (model type EXG-300). Each Meter shall be installed per the manufactures specifications and shall be commissioned and integrated with the existing University metering system by a Square D employee during start-up. This commissioning process shall be witnessed by Facilities Services - Utilities & Energy Management personnel. An Ethernet Cat 6 cable shall be routed from the nearest telecom connection point to provide communication link to the EGX 400.

Furnish a Square D PowerLogic WAGES utility metering panel, part number Q2C-19180117, complete with all microprocessors, software, programming, point data base, trends, terminal strips, and regulated power supply with battery backup.

The WAGES panel will require sensor wiring from the panel to primary supply and return temperature sensors in the Chilled Water, Heating Hot Water, and Domestic Cold Water, to be included as part of the ATC responsibilities.

This WAGES panel will require a dedicated 120V, 20 amp, single-phase emergency

electric circuit source installed by division 26.

This WAGES panel will require a category 6 Ethernet cable installed by the ATC.

A meeting between the TAMU Energy Office and the ATC contractor will be held as early as possible, prior to installation, to review the installation and finalize panel and wiring locations.

Each WAGES panel shall be installed per the manufactures specifications and shall be commissioned and integrated with the existing University metering system by a Square D employee during start-up.]

**Diesel Generator Requirements (Specific to TAMU/UEM):**

Generator equipment shall be supplied by a single manufacturer who has been regularly engaged in the sales and service of engine-generator sets, generators, engine auxiliaries, transfer switches, and controls for a minimum of fifteen years.

A manufacturer’s representative shall provide local factory-trained services, all required stock of replacement parts, and technical assistance.

Accessibility to the generator for service and fueling is critical. Coordinate each emergency generator installation with TAMU Utilities & Energy Management.

The fuel shall be diesel and be contained by a 24-hour double wall tank.

Life Safety Transfer Switch

Life safety loads are to be on a separate transfer switch from the legally required and optional generator loads.

The switch shall be fed from a separate overcurrent protective device in the generator.

Approved Generator Manufacturers

- Caterpillar
- Onan
- Kohler

Approved Transfer Switch Manufacturers

- Russelectric
- ASCO
- Zenith

## Tarleton State University

### Electricity Metering

Provide the ION 8600 Series digital meter manufactured by Square D Company.

### Lighting

#### Offices

Lithonia Lighting #2PM4-G-B-(# of lamps)-6(louver finish)-(one lamp ballast) GEB10IS  
Cooper Lighting #2HP3GX-(# of lamps)32S26I-NV-LGSP35M/OC8-HB81-U

#### Corridors, Restrooms, Break Rooms, etc.

Lithonia Lighting #2GT8-(# of lamps)-32-A12-MVOLT-(one lamp ballast)GEB10IS  
Cooper Lighting #2GC-(# of lamps)32A-UNV-LGSP35M/OC8-EB81-U

## West Texas A&M University

### Low-Voltage Conductors

#### Color-Coding

West Texas A&M University has adopted the following standard color-coding for all low-voltage circuit conductors.

Identify all wiring system conductors at each accessible location using color-coding that is consistent throughout the building. Refer to the table below for standard color-coding of wiring according to system operating voltage level.

*Note: For minor work in existing facilities use wiring color codes that match existing color codes so long as NEC® requirements for identifying grounded and grounding conductors are satisfied.*

| Color Code for Low-Voltage Conductors |                                |                                |                                |
|---------------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Line                                  | System Operating Voltage       |                                |                                |
|                                       | 240 / 120V<br>1-phase / 4-wire | 208 / 120V<br>3-phase / 4-wire | 480 / 277V<br>3-phase / 4-wire |
| Phase A or Line 1                     | Black                          | Black                          | Brown                          |
| Phase B or Line 2                     | Red                            | Red                            | Orange                         |
| Phase C or Line 3                     | N/A                            | Blue                           | Yellow                         |
| Neutral                               | White                          | White                          | Gray                           |
| Equipment Ground                      | Green                          | Green                          | Green                          |
| Isolated Ground                       | N/A                            | Green / Yellow Stripe          | Green / Yellow Stripe          |

**Design Criteria**  
**Division 26 – Electrical**

|                       |       |        |        |
|-----------------------|-------|--------|--------|
| Switched Leg          | Black | Pink   | Pink   |
| High Leg <sup>1</sup> | N/A   | Orange | Orange |

<sup>1</sup>Applies only to a 4-wire, delta-connected system where the midpoint of one phase winding is grounded. Refer to NEC Articles 110.15 and 408.3(F).

## Guide Specification

### Electric Motors

#### General

This specification addresses some of the mechanical and electrical design, electrical insulation system and testing requirements of premium efficiency low-voltage electric motors.

All motors conform to the following provisions:

Motors in NEMA frames 143T through 445T are 3 phase, 60 hertz, 230/460 volts.

Frames 447T and larger are 460 volt. All frames are also available in 575 volt.

Motors are suitable for continuous duty in ambient temperatures from -15°C to 40°C.

Operating altitude is 3300 feet or less.

All motors have a Service Factor of 1.15.

#### Electrical Requirements

All motors are the manufacturer's premium efficiency design.

The nominal efficiency and the minimum guaranteed efficiency are stamped on the nameplate of the motor.

All efficiency testing and labeling are done in accordance with the NEMA MG 1 standard.

All motors are capable of developing NEMA Design B locked rotor and pull up torque with 90% of rated voltage applied.

Conductors have increased cross sectional area for increased efficiency.

Low-loss electric grade silicon steel is used with interlamination insulation capable of withstanding of 1000°F burnout temperature.

The insulation system is Class F or better with a Class B rise at a 1.0 service factor.

Motors are multi-dipped and baked in Class H varnish.

Stator windings are copper.

Motor leads are stranded copper and are permanently identified and are brought out into the motor terminal box through a neoprene gasket.

### **Mechanical Requirements**

Stator frame and end brackets are a minimum of grade 25 cast iron construction. The terminal box volume is one size larger than NEMA requirements and rotatable in 90° increments.

External cooling fans are non-sparking corrosion resistant material.

Drain holes (Qty 2) are provided at the lowest points in the motor frame.

Bearings are either ball bearings or cylindrical roller bearings selected to provide a L-10 life of 40,000 hours with an external load per NEMA MG 1-14 and a L-10 life of 100,000 hours in direct coupled applications.

The motor nameplate is stamped on 304 stainless steel and fastened to the motor frame with four stainless steel drive pins.

All hardware is zinc-dichromate plated.

The motor is dynamically balanced to 0.6 mils peak-to-peak maximum displacement.

Motors are capable of all positioning mounting and operation.

### **Applicable Standards & Tests**

NEMA Publication MG 1-1993 Revision 1.

Testing per NEMA MG 1-12 (IEEE 112 Test Standard, Method B with segregated loss analysis).

All motors are given a routine test per NEMA MG-1, Section 12.

Class F insulation system is UL-Recognized per UL Safety Standard 1004.

Frame assignment per NEMA MG 1-13.

## **General Information**

Cable trays shall not to be installed over light fixtures.

## **Telecommunications Facilities**

The following paragraphs set forth the general telecommunications systems' design criteria for a campus major building. Adjustments will be necessary to meet the needs of lesser size buildings and special function buildings. Verify all special telecommunications (telephone and computer) requirements through the FPC Project Manager.

## **Telecom Equipment Rooms**

Telecom Equipment rooms shall comply with the following requirements:

Comply with Telecommunications Industry Association/Electronics Industry Association (TIA/EIA) Telecommunications Building Wiring Standards in every respect.

Minimum telecom room size. 10' x 9' - Reference: TIA/EIA 569 Table 7.2-1. A/E size the MDF room according to TIA/EIA for the services to be located in this room. Provide a scaled layout of this room at the Preliminary Design review.

MDF and IDF closets should be designed to accommodate a minimum of 50% increase in used rack space beyond the final building requirements.

All walls to have 8 ft covering of A/C plywood painted front and back with off-white or light grey fire retardant paint.

As stated in TIA/EIA 568A Section 4.3, the maximum horizontal run shall be 90 meters (295 feet). However experience has shown that cables can fail the required Category 5E/Category 6 length test when longer than 270 feet due to the twist in the pairs. Maximum cable length shall be 270 feet physical length, not tested length, measured from the punch down block in the telecom room to the most distant telecom outlet in the work area. This requirement determines the telecom room(s) locations.

Provide a minimum of one fourplex isolated ground 120-volt power outlet on each wall with a maximum of two fourplex outlets per circuit. These circuits are to be dedicated to the telecom room and are not allowed to serve any other load.

Provide one 30-amp 120-volt single phase outlet (L5-30R) inside each telecom room (two in the MDF room) and Owner designated server rooms to serve an owner furnished and installed UPS.

Provide the ground bus required by TIA/EIA-607.

Provide 7' x 19" racks and patch panels as appropriate to serve this building.

All telecom room walls must stack exactly with the telecom room located on the floor above and below it.

Telecom rooms shall not serve outlets on other floors except as necessary for under floor outlets not practical to run to the same floor telecom room. No open through hole penetrations are allowed to be made from conditioned space to unconditioned space (Example: outlets in the floor or in the wall where the cable drops down from a conduit stub into a cable tray in a basement crawl space).

No ceiling permitted in this room.

No means of liquid conveyance (water lines, sanitary or roof drain pipes, thermal, water, etc) may pass through electrical or telecom rooms. Exception: Sprinklers may be installed telecom rooms as required by NFPA Code.

Do not locate a fan powered box in any of electrical or telecom rooms. Telecom rooms shall be air conditioned.

Do not locate ductwork or plumbing clean outs in electrical or telecom rooms.

No crawl space access from electrical or telecom rooms.

A telecom room's air conditioning should be supported by emergency power if network attached devices in the building will be running on emergency power. For any building to be equipped with backup power, consideration should be given as to the need of the power for the telecom rooms to be supplied by the backup power system.

### **Building Telecommunications Entrance Facilities:**

Provide a minimum of four, four inch schedule 40 PVC (or equivalent) conduits between the building primary telecommunications terminal room and the telecommunications manhole, tunnel, or other service point as designated by FPC Project Manager and Facilities Department.

### **Building Primary Terminal Room Facilities:**

Provide a building primary telecommunications terminal room MDF sized in accordance with TIA/EIA -569 to terminate telecommunications entrance cables. This room shall house all fiber and copper service entrance equipment for the telephone, data and cable television distribution system, and all necessary wide area network equipment. Transformers, sound equipment, etc. that may generate objectionable electromagnetic radiation shall not be located in or adjacent to this room. As a minimum provide the



following in this room.

All walls to have 8 ft covering of A/C plywood painted front and back with off-white or light grey fire retardant paint.

Provide a minimum of one fourplex isolated ground 120-volt power outlet on each wall with a maximum of two fourplex outlets per circuit. These circuits are to be dedicated to the telecom room and are not allowed to serve any other load.

Ground (in accordance with NEC requirements) bonded to power ground with no more than five OHMS resistance.

Lighting, 30 foot candles.

HVAC on a separate VAV box with no heating water coil.

Telecom racks and patch panels as required.

Line protectors for outside plant telephone cables.

Two 30 amp 208 volt single phase outlet for future UPS.

Equipment outlets mounted should be 120V 20A duplex receptacles mounted at the base of each equipment rack.

Termination point for a telephone and fiber riser cables to each floor.

Provide an emergency panelboard for this room.

### **Floor/zone Terminal Closet Facilities:**

Provide a minimum of one telecommunications terminal closet per floor sized in accordance with TIA/EIA-569 to terminate telecommunications building distribution cables. As a minimum, provide the following in each closet:

All walls to have 8 ft covering of A/C plywood painted front and back with off-white or light grey fire retardant paint.

Provide a minimum of one fourplex isolated ground 120-volt power outlet on each wall with a maximum of two fourplex outlets per circuit. These circuits are to be dedicated to the telecom room and are not allowed to serve any other load.

Minimum of four, four-inch conduit sleeves to terminal room and other closets for both data and telecommunications cables. Conduits bend radius not less than thirty inches.

Termination point for station cable distribution facilities from each telecommunications

outlet served by a particular floor/zone closet.

Illumination level average, 30 foot candles.

HVAC as required.

Provide telecommunications racks and patch panels as required.

One 30 amp 120 volt single phase outlet for future UPS.

Terminal closets should be located such that the physical wiring distance does not exceed 270 physical feet (not tested feet) to the most remote outlet.

Terminal closets should be stacked vertically. Provide 12-strand multi mode (MM) and 6-strand single mode (SM) fiber optic backbone cable between MDF room and all IDF rooms in a star configuration.

### **Station Telecommunications Cable Distribution Facilities:**

Provide overhead cable tray raceway (or equivalent) from each floor/zone closet as the distribution backbone for all station outlets being served by a particular closet. Provide a 1" EMT conduit (not to exceed 100 feet length) between the serving raceway and each station outlet box. Telephone power poles, if used, shall be connected to the serving raceway in a similar manner. Separate all telephone cables from data cables in the cable tray and stove-pipe the cables from the entrance of each telecommunications room to the patch panel.

All outlet jacks, patch panels, racks, cables, and other hardware shall meet the requirements of TIA/EIA 568-A Category 6. Pinout to be 568a. Cables shall be rated category 6E to provide additional overhead bandwidth.

Install a pull cord in all empty conduits.

### **Station Telecommunications Outlet Facilities:**

Unless noted otherwise, furnish telecommunications workstations with the following items:

Adequate lighting for office work throughout the room, and 120 VAC duplex convenient outlets located where necessary by consultation with User and in compliance with the National Electric Code. Provide special CRT diffusers on lighting fixtures.

One-15/20A, 120 VAC, isolated ground, duplex convenience outlet where deemed necessary in consultations with the User (computer outlet).

One-15/20 amp, 120 VAC, standard duplex convenience outlet where deemed necessary in consultations with the User.

Two computer and two telephone outlets and Category 6E cables for a total of four. Ground box and conduit in accordance with NEC.

## **Cable Testing**

Telephone and Data Systems - The Contractor shall test the computer (data) and telephone wiring systems for conformance with the TIA/EIA 568-A Category 6E wiring standards. Provide complete test results, from a level IV test unit, in PDF format. Included on the test result for each station cable should be the outlet number and room number. Also, in Excel spreadsheet form, a list of outlet numbers and the corresponding room numbers and cable lengths, should be provided. As built drawings indicating each outlet location and outlet number should be provided in PDF format. All documentation should be provided on a compact disk or DVD.

Warranty- It is the intent that the complete cabling system be installed to satisfy 20-year minimum warranty requirements of the cabling infrastructure manufacturers.

## **Additional Requirements**

Cable--communications cabling shall be of a fire retardant "open air plenum" type; meeting all federal and state fire codes. The cable shall be four pair, 23 or 24 AWG cable Category 6 cable. Cable shall have cable length markers minimum every two feet and relevant UL markings. Cable type to be above base level category 6 cable, equivalent or better than Berk-Tek Lanmark 1000. Acceptable cable manufacturers are Berk-Tek, Mohawk, Superior-Essex. Jacket color shall be blue.

Two horizontal managers should be provided for each 48-port patch panel provided. 10% additional patch panels, horizontal managers, outlet jacks, and faceplates should be provided above the number installed. Two patch cables per installed patch panel ports should be provided in the lengths and colors:

White patch cables = number of voice outlets. 90%=5ft, 5%=10ft, 5%=15ft

Black patch cables = number of data outlets. 5%=3ft, 45%=5 ft, 45%=15 ft

Black patch cables = number of voice outlets+data outlets. 90%=10 ft, 10%=20 ft

Longest path routing in wiring closets should be used to provide additional cable for an equivalent service loop of at least 2 meters.

To allow for future growth inside of wiring closets, racks should be placed to maximize the number of racks that can be fit into the available space.

Finish color for racks and associated patch panels, vertical and horizontal managers

should be black.

Racks should be two-post 7 ft X 19" equipment racks with TIA/EIA standard hole spacing and with rack unit markings.

In general, the rack closest to the wall should contain the fiber panel, the next rack over would be for voice patch panels, switches, and 48V DC supply, the next rack over for data patch panels, and the next rack for data switches.

Cable tray used in the wiring closets and for distribution should be basket tray, sized appropriately for cabling capacity necessary for the building at a fill rate of no more than 40%. Acceptable manufacturers are B-line/GSMetals/Flextray and Cablofil.

Perimeter cable tray should typically be installed in the wiring closets. Cable tray should be mounted 4-6 inches above racks.

Firestop in high density wiring locations is preferably STI EZPath.

In general, cable runs should be in conduit back to the cable tray. Approximately 18" of slack should be left at the cable tray end of the conduit. The slack should be coiled and secured to the end of the conduit. Slack should not be left in the cable tray.

Good category 6 wiring practice should be followed throughout:

Cable sheath stripped back minimum necessary to complete the termination.

No wire pairs untwisted more than 1/2".

Cabling should be installed without kinks.

Bend radius should be greater than 4 times the cable diameter.

No damage allowed to the sheath. If damaged, cable should be replaced.

Cabling runs should be installed at least 6 inches away from fluorescent lights in suspended ceilings and 1 ft from power outlets.

Velcro cable ties should be used and not compress wire bundles.

Cable bundles should be supported as appropriate using industry-standard fittings.

Cable runs should be separated from power cabling by a minimum of 1 ft parallel and 3 inches crossing.

Two cables should be installed to each location designated for a wireless access point. As a general rule, wireless access point locations should be planned for on a 60 ft grid, modified as necessary to make allowance for the building structure and for the areas intended purposes. For above ceiling locations, each cable should be install with a 20 ft service loop at the access point end. The cables should be terminated with an RJ45 plug or RJ45 outlet in a two port surface mount plenum-grade mount. Wireless access points should generally not be located in ceilings above 14 ft. In those locations, strong consideration should be given to a wall mounted outlet. Wall mounted outlets for access points should be located no more than 14 ft high.

All Category 6 cable installed should be tested to the complete category 6 test standards

for permanent link using a Level IV test unit such as a Fluke DTX-1800. The unit must have been calibrated within the last year. Proof of calibration should be provided at the pre-testing meeting.

Labeling of patch panels, cables, and outlets should adhere to the campus labeling standard. Verify labeling scheme with the campus IT department.

Fiber riser cables from the MDF to the IDFs can be armored or can be installed in subduct. Subduct preference is for Maxcell.

Fiber cables in the wiring closets should be fusion spliced to factory-made ST UPC pigtails.

Fiber patch cables should be provided equal to the number of fiber strands terminated times 2. Single mode patch cables should be yellow, UPC polish, factory made, with test results provided, in the following lengths:

ST-LC, 3m - 50%

ST-ST, 3m - 50%

ST-LC, 5m- 50%

ST-ST, 5m-50%

All fiber installed should be tested with an OTDR suitable for the media and length and full test results provided.

All data contractor installation personnel must be BICSI Certified Installer Level I or higher. The onsite supervisor of the data contractor must be a BICSI Certified Technician. The data contractor must have on staff a BICSI Certified RCDD. All certifications must be current. Proof of certification must be presented at the pre-installation meeting.

## **Intercom and Audio Video Systems**

Coordinate all requirements for intercom, video, and audio equipment with FPC Project Manager and User Coordinator. Provide power outlets, conduit, wire and grounding as required. Provide a cable television distribution system. As a minimum, provide a complete sound system including ADA/TAS hearing assistance system and all reasonable infrastructure for audio-visual equipment and appurtenances for all classrooms, meeting rooms, and auditoriums whose seating capacity exceeds 50 seats.

## **Cable Television System**

Provide all cabling, RF Amplifiers, RF Passives, and all appropriate accessories to for a complete and operating RF distribution system capable of delivering distortion free video, audio, and data signals.

The RF distribution system should be capable of delivering CATV Channels 2 through 135. The RF distribution system begins at the centralized demarcation point in the MDF Room and ends at the wall outlet locations.

The RF distribution system should be two way compatible with the ability to transmit all frequencies between 5 and 40 MHz from the wall plate back to the demarcation point

Locate all amplifiers, splitters, and multiport directional couplers in a telecommunications room. Homerun all cables between the telecommunications room and wall outlets with cable lengths not to exceed 300 feet.

All forward amplifiers shall have a minimum of 30 dB gain and a minimum bandwidth of 54 – 862 MHz with a flat frequency response no greater than 1.5 dB.

All reverse amplifiers shall have a minimum of 16 db of gain and a minimum bandwidth of 5 – 40 MHz with a flat frequency response no greater than 1.5 dB.

All cables between the demarcation point, amplifiers, splitters, and multiport directional coupler locations shall be plenum rated, bonded-foil tri-shield construction Type RG-11 coaxial cable.

All cables between multiport directional coupler locations and wall outlets shall be plenum rated, bonded-foil tri-shield construction Type RG-6 coaxial cable.

All splitters used to divide trunk runs and multiport directional couplers used to feed wall outlets shall be 5 MHz to 1 GHz, 130 dB RFI shielding and solder-sealed precision machined F ports.

Connectors shall be F-type and designed to be used with the installed cable.

Non-locking 75 ohm terminators shall be installed on all unused ports on splitters and multiport directional couplers.

The forward signal level at each wall outlet shall have no greater than a 10dB tilt across the bandwidth of the distribution system, 54 to 862 MHz. The signal level shall not fall below 0 dBmV and shall not exceed 15 dBmV.

## Campus Specific Information

### Texas A&M University

#### Telecommunications and Computer Infrastructure Requirements

These requirements are in addition to the General Information section. The General Information section should be used as the starting point. This section is intended to provide additional guidance for the College Station campus to the A/E to provide infrastructure wiring to support both voice and data communications.

#### Telecom Equipment Rooms

Provide 120V 30A outlets (L5-30R) located as needed at the base of the rack locations should be installed for a 48 VDC supply in the MDF and in the appropriate telecom rooms. Typically, this will require three outlets in the MDF and one in each IDF.

Equipment outlets should be 120V 20A duplex receptacles mounted at the base of each equipment rack.

#### Building Primary Terminal Room Facilities:

Provide 120V 30A outlets (L5-30R) located as needed at the base of the relevant rack locations should be installed for a 48 VDC supply in the MDF. Typically, this will require three outlets in the MDF.

Equipment outlets should be 120V 20A duplex receptacles mounted at the base of each equipment rack.

#### Floor /zone Terminal Closet Facilities:

Provide 24-strand single mode fiber optic backbone cable between MDF room and all IDF rooms in a star configuration. For each IDF room within 270 physical feet of the MDF, provide 12 category 6 cables terminated to patch panels separate from the station cables. Additional fiber and copper tie cables may be needed for large IDFs with more than 240 station cables.

Equipment outlets should be 120V 20A duplex receptacles mounted at the base of each equipment rack.

Provide a 120V 30A outlet (L5-30R) at the base of the relevant equipment rack for the 48V DC supply.

### **Station Telecommunications Cable Distribution Facilities:**

All outlet jacks, patch panels, racks, cables, shall meet the requirements of TIA/EIA 568-A Category 6. Pinout to be 568B.

### **Station Telecommunications Outlet Facilities**

Each station outlet shall have a deep (3-1/2 inch) dual gang box with a dual gang faceplate.

Two one inch conduits shall run from the outlet box to the nearest cable tray.

Outlet box should be located a minimum of 1 foot from nearest power outlet.

### **Cable Testing**

Provide complete test results, from a level IV test unit, in PDF format. Included on the test result for each station cable should be the outlet number and room number. Also, in Excel spreadsheet form, a list of outlet numbers and the corresponding room numbers and cable lengths, should be provided. As built drawings indicating each outlet location and outlet number should be provided in PDF format. All documentation should be provided on a compact disk or DVD.

### **Additional Requirements for Texas A&M University:**

The A/E design team shall include a data/voice/audio/video design consultant with BICSI RCDD credentials and with extensive previous experience in university building design environment. The consultant should also provide support during the construction process to verify that the submittals, test procedure and actual installation meets the requirements as specified for the project.

Warranty- It is the intent that the complete cabling system be installed to satisfy 20-year minimum warranty requirements of the cabling infrastructure manufacturers.

MDF and IDF closets should be designed to accommodate a minimum of 50% increase in used rack space beyond the final building requirements

Cable--communications cabling shall be of a fire retardant "open air plenum" type; meeting all federal and state fire codes. The cable shall be four pair, 23 or 24 AWG cable Category 6 cable. Cable shall have cable length markers minimum every two feet and relevant UL markings. Cable type to be above base level category 6 cable, equivalent or better than Berk-Tek Lanmark 1000. Acceptable cable manufacturers are Berk-Tek, Mohawk, Superior-Essex. Jacket color to be blue.

An appropriate number of outlets for voice and data communications are to be installed



in the various areas as per the building user requirements.

A typical station outlet in a single occupant office is to have 4 category 6 cables, 2 for data and 2 for voice. Two RJ-45 jacks are to be mounted in the upper portion of the left gang of the outlet faceplate for data and two RJ-45 jacks are to be mounted in the lower portion of the left gang of the dual gang faceplate for voice. The right gang of the outlet box should be filled with blanks. Jacks or outlet covers should have provision for station type indicators (data or voice) and outlet labels. Jacks are to be wired as TIA/EIA-568B. Acceptable manufacturers are Ortronics, Leviton, and Hubbell. Part numbers for TAMU supported outlets should be obtained from TAMU Networking.

Category 6 patch panels should be 48-port. No angled patch panels. Data cables should be terminated on patch panels separate from the voice cables. Horizontal managers should be 2U with attached covers. Ten inch double sided vertical managers should be placed between racks. Six inch vertical managers should be placed at the row ends.

Two horizontal managers should be provided for each 48-port patch panel provided. Ten percent additional patch panels, horizontal managers, outlet jacks, and faceplates should be provided above the number installed. Two patch cables per installed patch panel ports should be provided in the lengths and colors as proportioned by TAMU Networking and TAMU Telecommunications for the specific building. As a starting point:

White patch cables = number of voice outlets. 90%=5ft, 5%=10ft, 5%=15ft

Black patch cables = number of data outlets. 5%=3ft, 45%=5 ft, 45%=15 ft

Black patch cables = number of voice outlets+data outlets. 90%=10 ft, 10%=20 ft

Longest path routing in wiring closets should be used to provide additional cable for an equivalent service loop of at least 2 meters.

To allow for future growth inside of wiring closets, racks should be placed to maximize the number of racks that can be fit into the available space.

Finish color for racks and associated patch panels, vertical and horizontal managers should be black.

Racks should be two-post 7 ft X 19" equipment racks with TIA/EIA standard hole spacing and with rack unit markings.

In general, the rack closest to the wall should contain the fiber panel, the next rack over would be for voice patch panels, switches, and 48VDC supply, the next rack over for data patch panels, and the next rack for data switches. In the MDF, an additional rack space may be needed to accommodate the 48VDC supply.

Cable tray used in the wiring closets and for distribution should be basket tray, sized appropriately for cabling capacity necessary for the building at a fill rate of no more

than 40%. Acceptable manufacturers are B-line/GSMetals/Flextray and Cablofil.

Perimeter cable tray should typically be installed in the wiring closets. Cable tray should be mounted 4-6 inches above racks.

Firestop in high density wiring locations is preferably STI EZPath.

In general, cable runs should be in conduit back to the cable tray. Approximately 18" of slack should be left at the cable tray end of the conduit. The slack should be coiled and secured to the end of the conduit. Slack should not be left in the cable tray.

J-hooks are allowed only on a case-by-case basis.

Good category 6 wiring practice should be followed throughout:

Cable sheath stripped back minimum necessary to complete the termination.

No wire pairs untwisted more than 1/2".

Cabling should be installed without kinks.

Bend radius should be greater than 4 times the cable diameter.

No damage allowed to the sheath. If damaged, cable should be replaced.

Cabling runs should be installed at least 6 inches away from fluorescent lights in suspended ceilings and 1 ft from power outlets.

Velcro cable ties should be used and not compress wire bundles.

Cable bundles should be supported as appropriate using industry-standard fittings.

Cable runs should be separated from power cabling by a minimum of 1 ft parallel and 3 inches crossing.

Two cables should be installed to each location designated for a wireless access point. As a general rule, wireless access point locations should be planned for on a 60 ft grid, modified as necessary to make allowance for the building structure and for the areas intended purposes. For above ceiling locations, each cable should be installed with a 20 ft service loop at the access point end. The cables should be terminated with an RJ45 plug or RJ45 outlet in a two port surface mount plenum-grade mount. Wireless access points should generally not be located in ceilings above 14 ft. In those locations, strong consideration should be given to a wall mounted outlet. Wall mounted outlets for access points should be located no more than 14 ft high.

All Category 6 cable installed should be tested to the complete category 6 test standards for permanent link using a Level IV test unit such as a Fluke DTX-1800. The unit must have been calibrated within the last year. Proof of calibration should be provided at the pre-testing meeting.

Labeling of patch panels, cables, and outlets should adhere to the TAMU Labeling standard. A current copy is available from TAMU Networking. Acceptable manufacturers for labels are Brady and Panduit.

Fiber riser cables from the MDF to the IDFs can be armored or can be installed in subduct.

Subduct preference is for Maxcell.

Fiber cables in the wiring closets should be fusion spliced to factory-made ST UPC pigtails.

Fiber patch cables should be provided equal to the number of fiber strands terminated times 2. Single mode patch cables should be yellow, UPC polish, factory made, with test results provided, in the following lengths:

ST-LC, 3m - 50%

ST-ST, 3m - 50%

ST-LC, 5m- 50%

ST-ST, 5m-50%

All fiber installed should be tested with an OTDR suitable for the media and length and full test results provided.

There should be a pre-installation meeting with the general contractor, data contractor, FPC Project Inspector, and TAMU Networking representative to review the installation requirements and planned installation.

There should be a pre-testing meeting with the general contractor, data contractor, FPC Project Inspector, and TAMU Networking representative to review the test requirements and plan for all fiber and copper installed.

All data contractor installation personnel must be BICSI Certified Installer Level I or higher. The onsite supervisor of the data contractor must be a BICSI Certified Technician. The data contractor must have on staff a BICSI Certified RCDD. All certifications must be current. Proof of certification must be presented at the pre-installation meeting.

Itemized unit pricing per cable/outlet jack should be provided as part of the submittals for use in adding additional cabling during the project.

## **Emergency Telephones**

Emergency Telephones will be installed outside of new campus buildings as specified by the TAMU Campus Safety Committee. Where requested the telephones will be provided and installed by the contractor. Manufacturer to be RamTel with the following features:

- PLC8 Stainless Steel Column Light
- 1 - GBF-2 Glass bead Finish
- 1 - RR735
- 1 500-1179 J Bolts and Template

Infrastructure will include a 20"x20' by 3'6" deep footing with 4 J-hooks inserted. A template for the slab and J-hooks will be provided by TAMU Telecommunications.

The project will also provide a 20 amp 110Volt AC circuit from the building to the slab installed in conduit and a one inch vacant conduit for communications wiring.

### **Distributed Antenna System (DAS)**

Texas A&M University has a DAS system on several buildings. All new buildings will be DAS enabled. To accomplish this the building have a 1½ inch conduit installed to a location to be determined on the roof with 6 20 amp circuits terminated in a junction box. Adjacent to the electrical box, the contractor will install a 20"x20"x6" or larger NEMA 4 weatherproof enclosure with a 1½ inch conduit terminated above the ceiling of the top floor. This conduit is for future DAS fiber optic cable.

### **Audio/Video for Registrar-controlled Classrooms**

All of the equipment and cabling listed is needed as specified or equivalent items may be substituted in order to meet the requirements.

Mounted Equipment requirements:

- Chief CMA440 Lightweight Above Tile Suspended Ceiling Kit
- Hoffman A20N16BLP-CUSTOM Hub Box (NEMA 1 ENCL-BLACK/VENTED HOFFMAN \*\* DIRECT ORDER \*\* T009 color with lock and 4" louvers on each side) with HOFFA20N16MP Panel
- Electric Projection Screen of adequate size for the room
- DA LITE 40973 Single Motor Low Voltage Controller installed at Screen with proper switch Installed in wall near lectern location
- In smaller rooms, where smaller speakers will suffice, ceiling mount JBL 8Ω Speakers need to be installed, for larger applications, a more specific speaker system will need to be decided upon.

Wire Runs:

- Liberty cable 22-2P-CMP-Siamez audio cable/Plenum rated or equivalent
  - Position:
    - Back of room with Hub Box housing running to front of room inside lectern.
      - 2 sets of the 22-2P-CMP-siamez audio cable.
- Liberty cable 20-3C-PS-WHT speaker cable/Plenum rated or equivalent
  - Position:
    - Back of room with Hub Box housing running to front of room inside lectern.
      - 1 set of the 20-3C-PS-WHT

- Middle of room from from first ceiling speaker to front of room inside lectern. This wiring configuration is to support stereo audio and the installed speakers should be wired as such.
  - 1 sets of the 20-3C-PS-WHT
- Low voltage controller by screen to inside lectern
  - 1 set of the 20-3C-PS-WHT
- Cat 6 cable/Plenum rated
  - 1 cat 6 cable running from Black Box housing to front of room inside lectern.
    - Used for feeding video back into computer via s-video over ethernet adapter.
  - 3 cat 6 cables running from projector to front of room inside lectern.
    - 1 cat 6 line used for serial communication
    - 1 cat 6 line used for vga over ethernet
    - 1 cat 6 line used for s-video/video over ethernet connection

Power Receptacles requirements:

- Hub Box
  - 8 total outlets inside box (two Quad/Double-Gang Receptacles).
- Projector
  - 2 total outlets attached to projector ceiling plate visible below ceiling tile.
- Lectern
  - Power receptacles added under podium via conduit hidden beneath stage or floor.
    - If unavailable, receptacles should be located as close to podium as possible.
    - A total of four (4) power outlets are needed

Network Connection using Category 6 cable Requirements:

- Two network connections ran to Lectern Location with 10 Foot of slack outside conduit
  - One of the connections will have a network switch installed on it to split the connection for the Lectern Equipment
  - The remaining connection will be for the Laptop Connection
- One network Connection located at the back of the room for the camera. The camera location will vary depending on the entrance to the classroom, equipment location, as well as structural limitations such as support posts, etc. Having enough slack on this line will be crucial

## **Metering & Building Automation Communications**

All buildings will have meters installed that record consumption. These meters will utilize the campus Ethernet and the Category 6 communication cabling within the building. The PowerLogic electric meters and the WAGES PLC will utilize a Category 6 Ethernet cable to a EGX-400 Ethernet gateway. The Siemens DDC systems will communicate with a Category 6 communication cable to a designated DDC panel, a

separate additional communications network, specifically for the DDC system, using Category 6 cable will be installed for communications between the DDC panels. This separate DDC communication network will have the Category 6 wiring installed by the ATC. Any switches, terminations, and set-up and integration will be provided by the owners Siemens representative as part of the owner provided DDC system. This separate network will be managed and maintained by the Utilities and Energy Management.

## **West Texas A&M University**

### **Telecommunications and Computer Infrastructure Requirements**

|                   |  |
|-------------------|--|
| Data Outlets      | Ortronics Series II & fully compliant with EIA/TIA 568A<br>Data jacks will be 8 pin keyed RJ-45<br>Voice Jacks will be 6 pin RJ25C |
| Connecting Blocks | Ortronics OR-851044562 with trough for data termination<br>Ortronics OR-30200020 for voice termination                             |

## **Tarleton**

### **Summary**

This document identifies Tarleton State University communication infrastructure standards. The communication infrastructure supports the campus voice, data and cable television communication network. Prior to any cable being pulled at Tarleton, Telecom is required to obtain approval from the Director of Risk Management to certify the cable route is asbestos free.

Tarleton purchases and installs components for a structured cable system utilizing a Belden/ Ortronics integrity solution. Ortronics provides Tarleton with a 25-year system and applications warranty on all parts and labor. Warranty commences at the time of completion. Tarleton Technicians are Belden/Ortronics integrity certified installers and are authorized to provide cable warranty certifications.

### **Quality Assurance**

Tarleton uses and installs materials and equipment in compliance with the latest applicable standards from ANSI, FCC, ASTM, TIA/EIA, IEEE, NEC, NFPA, NEMA, REA and UL includes but not limited to.

- A. ANSI/TIA/EIA-568-C.0 and C1 Standards, Commercial Building Wiring Standard

- B. ANSI/TIA/EIA-569-A Standard, Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. ANSI/TIA/EIA-570 Standard, Residential and Light Commercial Building Wiring Standard.
- D. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- E. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
- F. Institute of Electrical and Electronic Engineers (IEEE) Standards
- G. Underwriters Laboratories (UL)
  - 1. UL 467 Grounding and Bonding Equipment
- H. National Electrical Code (NEC) (Latest revision and pertinent addendums)
- I. National Fire Protection Association (NFPA) Publications (Latest revision and pertinent addendums)

Information outlets for data and voice communication shall be fed using the horizontal cable system. The horizontal system consists of plenum rate 4-pair Unshielded listed Pair (UTP) Belden cable (CAT 6). Information outlets will accommodate future installation of telephone, computers, and modems.

A. Horizontal Wiring System (voice & data)

- 1. Tarleton Cable pulls are no longer than 270 feet.
- 2. CAT 6E is cable is orange for data and white for voice. It is used for all new construction or if specifically requested.
- 3. The 568B Pinout sequence is always used.
- 4. A 36” service loop is provided in the ceiling above each jack location for all copper cables. These service loops shall be neatly dressed and properly supported.
- 5. Voice cable is terminated on 110 Cat6 Patch Panels in the closet and RJ45 flush mount jacks at work station.
- 6. Data cable is terminated in 19” equipment rack mounted Ortronics patch panels in the closet and RJ45 flush mount jacks at the work station.
- 7. Caddy J hooks are installed to support all horizontal cables. J hooks are installed no more than five (5) feet on center and are installed using only Caddy approved installation methods and materials.
- 8. All conduct, sleeves or any other penetrations are properly fire-stopped.
- 9. All conduits for data and voice workstations will be stubbed out the nearest cable tray.

B. Equipment Room

Contractor must use the appropriate Industry codes and standards. Contractor must submit a proposed layout to Tarleton Telecom for approval prior to 100% design completion.

C. Intrabuilding Fiber Optic Cable

Contractor is responsible for installing, terminating, labeling and testing any required intrabuilding fiber. Contractor must submit a proposed cable route to Tarleton Telecom for approval prior to 100% design completion.

D. Intrabuilding Copper Cable

Contractor is responsible for installing, terminating, labeling and testing any required intrabuilding fiber. Contractor must submit a proposed cable route to Tarleton Telecom for approval prior to 100% design completion.

## Testing

A. Each data run is tested to compliance with ANSI/TIA/EIA standards, including but not limited to, continuity, length, anomalies, and attenuation.

B. Records are maintained on all test results.

Fiber terminations are outsourced but require bi-directional OTDR testing, including launch and landing reel as well both wavelengths for each type of fiber specified

## Identification, Labeling and Documentation

A. Tarleton labels all terminal blocks, patch panels, cabling pairs, wiring pairs, and both ends of each cable between the work station outlet and the closet.

B. Tarleton uses a mechanically generated white label with black lettering to label both the outlet face plates and patch panel.

C. Tarleton's labeling scheme is customized.

## Approved Equipment List

Fiber: Corning (Siecor)- ST connectors

Outdoor Fiber-

**Singlemode Fiber-Optic Backbone:**

48-strand, outside plant type for duct installation

8.3/125 Singlemode

Wavelength 1310/1550 nm

Dry water blocking technology

Standard 3.0 mm buffer tube size



Stranded, loose tube design  
Maximum attenuation 0.5/0.4 dB  
All dielectric construction  
10 Gigabit Ethernet Distance of 1000meters @ 1310nm; 40000meters @ 1550nm  
light wave

**Multimode Fiber-Optic Backbone:**

48-strand outside plant type for duct installation  
62.5/125Nm Cable  
Wavelength 850/1300 nm  
Dry water blocking technology  
Standard 3.0 mm buffer tube size  
Stranded, loose tube design  
All dielectric construction  
Serial Gigabit Ethernet Distance of 500m @ 850nm; 1000 m @ 1300nm light wave

**Indoor Fiber Singlemode Fiber-optic Backbone:**

24-strand Singlemode Cable  
900 Nm Tight-buffered  
OFNR Riser-rated, Flame Retardant jacket  
All dielectric construction  
10 Gigabit Ethernet Distance of 10000meters @ 1310nm; 40000meters @  
1550nm light wave  
Acceptable Products:  
Corning MIC Riser, Part Number 024R81-33131-24

**Indoor Fiber Multimode Fiber-optic Backbone:**

24-strand Multimode Cable  
900 Nm Tight-buffered  
OFNR Riser-rated, Flame Retardant jacket  
All dielectric construction  
Serial Gigabit Ethernet Distance of 500m @ 850nm; 1000 m @ 1300nm light wave  
Acceptable Products:  
Corning MIC Riser, Part Number 024K81-33150-24

Rack Mount Fiber Cabinet (item CORNING CABLE SYSTEMS CCH-01U)

Fiber Adapter Panels Multimode Refer to vendor for correct panel size and part  
number for ST ends

Fiber Adapter Panels Single mode Multimode Refer to vendor for correct panel  
size and part number for ST ends

Composite Ferrules

All fiber termination will be fusion spliced using Corning manufactured pigtailed.

**Copper: Essex PE-89**

The voice cables will be jumped with a 25 pair cables from the Circa to an Ortronics patch panel.

The horizontal voice will be terminated on an Ortronics patch panel.

Building Entrance- Circa 1880ECA1-100G for backbone cable

The voice cables will be jumped with a 25 pair cables from the Circa to an Ortronics patch panel part #. OR-PHD-66U48

The horizontal voice will be terminated on an Ortronics patch panel.

**Voice& Data Workstation Wiring: Belden/Ortronics (EIA-TIA 568B)**

Cable: Belden Cat6 (item # 7882A), Data - Orange, Voice - White

**Hardware, general- Ortronics**

Faceplates (item # OR-40300158)

Blanks (item# OR-40300164)

**Hardware, Cat 6 – Ortronics**

Single Data or Voice Jack (item # OR-S21600)

Double Data or Voice Jack (item # OR-S22600)

Patch Panel (item # OR-PHD-66U48)

**Equipment Racks**

**Ortronics Rack**

OR-604004600 19 inch 7 feet tall

Horizontal cable management- OR-808044549

Vertical Cable Management –OR-60400437

**Raceways and Cable Trays**

**A. Center Spline Cable Tray:**

1. Standard 10' aluminum sections
2. Tray depth 4"
3. Tray width 9"
4. Rung spacing 9", factory fitted end caps
5. Provide outside tray enclosure (bottom cover) and screw-down top cover in open-ceiling areas
6. Load bearing Class Nema 12C, 161 Lbs per linear foot
7. Provide elbows, tees, crossovers, cable roll-outs, stiffener bars and all support and mounting hardware
8. Acceptable Product:

- a. Wiremold SpecMate
    - 1) CA040909 9" W X 4" D Center spine cable tray
    - 2) A0412-120-DOTE - Outside Tray Enclosure for Tray
    - 3) Tray Top Cover
  - b. Cooper B-Line
    - 1) C4ADT09-09-120 9"W X 4" D Center spine cable tray
- B. Telecommunications Rooms Cable Tray:**
- 1. Ladder Type Cable Tray.
  - 2. Tray width 18"
  - 3. Provide unobstructed access to tray cantilevered wall-mount, or stand-off of equipment racks
  - 4. Provide elbows, Tees, crossovers, cable roll-outs, and hardware as required for complete system
  - 5. Acceptable Product:
    - a. WireMold SpecMate F Series
      - 1) CF040918 18" Aluminum Ladder Tray
    - b. Cooper B-Line
      - 1) 34A09-18-120 18" Aluminum Ladder Tray

### **System cabling and wiring**

General: Provide proper cabling, connections, and terminations for CAT 6E cabling installation.

The station cabling shall extend from each designated data and telephone jack to the assigned TR or the ER, in a star topology.

The cable shall not be crushed, deformed, skinned, crimped, twisted, or formed into tight radius bends (no less than 6 inch inside radius) that could compromise the integrity of the cabling.

Communications cable must not be fastened to electrical conduits, mechanical ductwork/piping; sprinkler pipes, or routed to obstruct access to doors, utility access panels, or service work areas.

Take precaution to prevent and guard against electromagnetic and electrostatic interference and hum. Do not route cables through ventilation shafts, nor parallel with line-voltage electrical conductors.

Communication cables shall not be run loose or laid upon on ceiling grid or ceiling tiles.

Cables shall be run in bundles above accessible ceilings and supported with cable support devices attached to building structure.

Cable bundles shall be run down the perimeters of the main corridor whenever practical.

Provide cable rated for environmental air type plenum where required.

Avoid cable stress due to cable twist during pulling or installation, tension in suspended cable runs and tightly cinched cable ties.

Support shall be provided by mounting appropriate cable supports for the quantity of cables in the route.

The support wires for the ceiling grid or light fixtures shall not be utilized.

Any cable support device shall not interfere with inserting or removing ceiling tiles.

The cable pathway must be positioned at least 6 inches above the ceiling grid.

### **UTP Connector Termination**

Install Category 6E cable compliant with TIA 568B with 568B pinout.

Strip wire jackets only as much as is required to terminate individual pairs.

Pair twist are to be maintained as close as possible to the point of termination to lessen near end crosstalk (NEXT).

Untwisting of pairs is not to exceed 13mm (1/2 inch) for Category 6 UTP cable.

Install connecting hardware in a manner to provide a well-organized installation with cable management, and in accordance with manufacturer's guidelines.

### **Horizontal UTP Cabling**

Horizontal cable run-length shall be no greater than 270 ft from the outlet to the horizontal cross connect, inclusive of ten feet of slack.

Install cable so that the pulling tension applied to the cable does not exceed 25lbf or the manufacturer's guidelines whichever is lesser.

Install cable so that a radius bend of no less than six times the cables outside diameter is maintained.

Maintain a six-inch minimum clearance between the bottom of the cable tray pathway structure and the top of the ceiling.

Maintain a six-inch minimum clearance between the sides of the cable tray pathway structure and adjacent walls or other distribution systems.

Install horizontal pathways in such a manner that the minimum bend radius of the

horizontal cables is kept within the manufacturer's specifications, both during and after installation.

### **Cable management in Horizontal pathway**

Maintain proper conduit bend radius in accordance with ANSI/EIA/TIA-569-A.

For conduit with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal conduit diameter. For conduit with an internal diameter greater than 2" maintain a bend radius of at least 10 times the internal conduit diameter.

Cable within pathway system to be no less than six inches from fluorescent lighting, one foot from conduit or cables used for electrical power distribution, and four feet from large motors or electrical transformers.

Fire-stop penetrations through floors or rated walls per ANSI/EIA/TIA 569 and authorities having jurisdiction with approved methods and means.

### **Cable TV requirements**

RG-6 coax: Belden 9116 or P-10 PVCX1B or plenum equivalent

RG-11 coax: RG11U-RL Cabletronix 4 GHz or plenum equivalent (required for runs of 250'+)

RG-6 connector: PPC-EX6XL

RG-11 connector: PPC EX11N176 or PPC EX11

Hardware

Faceplates OR-40300158

Blanks OR-40300164)

TV jack OR-60900017

Closet will need one card access. Refer to one card specs.

### **Smart Classroom Requirements**

**Note:** Depending on the room configuration (for example if the space is to be used as a smart classroom), we would need the following;

The following should be considered whenever renovating smart classrooms and/or facilities with smart cart technology.

- Projectors will require power in the ceiling within a few feet of projector.
- Power will need to be available adjacent to the wall plate that connects smart cart
- There will need to be two data drops (PC and Room Control)

- Tarleton Representatives need to be included in the planning stages so that if we need smart cabling (speakers, VGA, cat5 for smart board, ect), we can ensure that these items are coordinated and installed during the project and not after.

**Note:** Network Infrastructure requires including the following; UPS, Wired and Wireless requirements, Closet power and cooling requirements.

## **General Information**

### **Fire Detection and Alarm Systems**

The Fire Detection and Alarm System shall be designed in accordance with NFPA 72 by a firm registered in the State of Texas and whose employees have a valid fire alarm planning superintendent's license or fire alarm technician license issued by the state fire marshal. All material shall be approved by Factory Mutual Laboratories and Listed by Underwriters Laboratories. Compliance with article 5.43-2, Texas Insurance Code is required.

All fire alarm systems shall be addressable systems.

## **Campus Specific Information**

### **Tarleton State University**

#### **Fire Alarm System**

Fire Alarm System shall be Notifier 320 panel, no substitutions allowed.

### **Texas A&M University-Commerce**

#### **Fire Alarm System**

Fire Alarm System shall be Notifier, no substitutions allowed.

### **West Texas A&M University**

Fire Alarm System shall be Siemens Pyrotronics

## Guide Specification

### Texas A&M University

#### Fire Alarms Specifications

**Purpose:** This guide specification shall serve as a design and installation standard for fire alarm systems installed on the Texas A&M University (TAMU) Campus.

##### **I. General Information**

- a. The contractor shall perform all work necessary to design, install, and test any new fire alarm system installation. This includes, but is not limited to, all labor, materials, and commissioning.
- b. The complete installation shall conform to the applicable sections of the most current edition of the National Fire Protection Association (NFPA) codes and standards, American Disabilities Act (ADA), the National Electrical Code, the International Building Code, the Texas Accessibility Standards Act (TAS), and these specifications.
- c. All fire alarm system retrofit projects shall include a field survey of the facility to determine device locations and system layout. The walkthroughs should include a member from the TAMU/TAMUS project management group, personnel from the Facilities Department, and Environmental Health and Safety.
- d. All components of the fire alarm system shall be able to interface completely with the fiber network reporting system used by Texas A&M University while maintaining a UL listing (See Annex B).

##### **II. General Design Guidelines**

All new fire alarm systems installations at Texas A&M University shall utilize the following general guidelines as a basis for the system layout. These general guidelines are for fully sprinklered buildings. These are general guidelines and may vary as determined by the AHJ during walkthrough and plan review sessions.

- a. Smoke detectors
  - i. Unless specified by the AHJ shall be photoelectric
  - ii. Shall be installed in the following locations:
    1. All corridors and common use spaces such as lobbies, reception areas, etc.



**Design Criteria**  
**Division 28 – Electronic Safety and Security**

- 2. Intermediate or remote areas where smoke would need to penetrate multiple doors to reach a smoke detector in a corridor or common area
    - 3. Electrical Rooms
    - 4. Storage rooms with large combustible loads
  - iii. Smoke detectors shall not be installed in
    - 1. Custodial closets
    - 2. Non-conditioned pump rooms
- b. Heat Detectors shall be installed in break rooms
- c. Manual pull stations shall be installed at the following locations:
  - i. Every level at every enclosed or exterior exit
  - ii. In corridors where travel distance to a pull station exceeds 200 feet
  - iii. Every horizontal exit as defined by NFPA 101, *Life Safety Code*®
- d. Specific design issues
  - i. High-rise building specifications
    - 1. Provide a fireman's phone system and boxes for phone
    - 2. Provide an unsupervised printer that shall record all system events and time of the event
    - 3. All high rise buildings will be programmed for general alarm activation (not high-rise mode)
  - ii. Residence Hall specific requirements
    - 1. Detectors in resident hall rooms shall be combination heat/smoke detectors. Activation of the heat/smoke detector shall sound a local and general alarm.
    - 2. Activation of a general alarm shall activate sounder bases in all resident hall rooms.
  - iii. Animal housing areas - Chimes may be installed in animal housing areas (system designer should verify with user to determine if and when this might be necessary.)

**III. Instructions to Contractors**

- a. The contractor shall provide three (3) copies of detailed plans, and specifications as enumerated in Appendix A for review and approval prior to installation.
- b. The contractor shall get clarification from the AHJ and approval from the FPC Project Manager when a question or discrepancy arises.

## Design Criteria

### Division 28 – Electronic Safety and Security

- c. Upon completion of the installation and testing of the system, the contractor shall provide a structured training class to designated university personnel on troubleshooting, maintenance and repair of the installed system as requested. A manufacturer representative shall be present.
- d. Contractor shall contact Radio Room and the Building Proctor before work is started each day.
- e. The contractor shall provide a price list identifying any special tools and/or equipment required for inspection, testing or maintenance of any installed components. The project manager will determine any equipment needed and provide a list to the contractor. The cost of this equipment shall be included in the contract price.
- f. The contractor shall provide within fourteen (14) calendar days of the acceptance test one (1) electronic copy in the native format of the BIM authoring software as well as the same information in IFC format and copies of all sheets of the Record drawings in DWG format as well as in PDF format on disk type media (CD or DVD) and three (3) hard copies of Record drawings reflecting any and all changes noted during acceptance testing. These drawing should be complete and detailed as enumerated in Appendix A. The drawings shall accurately reflect the installed system.

#### IV. Quality Control Assurance

- a. All components of the fire alarm system shall be products of an Underwriters Laboratories Inc. listed fire alarm manufacturer, and shall bear the UL label. Partial listing **shall not** be acceptable.
- b. All components of the fire alarm systems shall use the most current technology available.
- c. Only new parts shall be installed at the time of initial installation and to repair the system during the warranty period. No reconditioned parts shall be used.
- d. All devices shall be tested and certified that they meet or exceed the “Service Life Expectancy Rating” as outlined by UL and NFPA.
- e. The equipment and installation supervision furnished under this specification is to be provided by a manufacturer who has been engaged in production of this type of equipment (software-driven) for at least 5 years and has a fully-equipped service organization within 150 miles of the installation site. Service shall be provided within 24 hours of problem notification.

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

- f. All conductors shall be uniformly and consistently color-coded and labeled throughout.
- g. All power supplies connected to the system shall have transient protection in accordance with UL 864.
- h. Detectors **shall not** be installed until cleanup of all construction trades is complete as required by NFPA 72. Any detectors found installed prior to this cleanup will be replaced at the contractor's expense.
- i. Conduits shall not be filled to more than 40% capacity. Conduits shall have a J-box no further than 100 feet or at each 90<sup>o</sup> turn, whichever occurs first. All J-boxes shall be painted red or have the letters FA in red on the cover. Where a J-box at every 90<sup>o</sup> turn may be considered excessive, the contractor should get direction from the TAMU/TAMUS project manager before omitting any J-box. All J-boxes shall be easily accessible.
- j. The contractor shall identify and label circuit breakers on main and emergency power supplies and identify these electrical panel location(s) and breaker number(s) inside the Fire Alarm Control Panel (FACP) in accordance with NFPA 72. Any breaker associated with the FAS shall be painted red.

**V. Design Specifications**

- a. General Requirements
  - i. Panels shall be easily expandable and upgradeable.
  - ii. Unless otherwise approved by the Authority Having Jurisdiction (AHJ), the FACP shall have software that will enable the system to be intelligent.
  - iii. All Fire Alarm Systems (FAS) shall be equipped with voice notification and have public address capability unless otherwise approved by the AHJ.
  - iv. Provide software that:
    - 1. Is password protected
    - 2. Offers computer driven device calibration test and reporting features, by device, loop, or system.

## Design Criteria

### Division 28 – Electronic Safety and Security

3. Latches all Alarm, Trouble, and Supervisory signals, unless otherwise requested by AHJ.
- v. Power for the FAS (FACP and all components) shall be from one electrical panel unless approved by the AHJ.
- vi. Furnish and install “surge protection devices” on all circuits that extend beyond the main building (i.e. walkways, aerial, or underground methods):
  1. Surge protection devices shall be located as close as practical to the point where circuits leave the building.
  2. Surge protection devices shall have a line to line response time of less than one nanosecond capable of accepting 2000 amps to earth.
  3. Surge protection devices shall comply with UL 497B and NEC 760.
- vii. All addressable loops shall have loop isolation protection devices to maintain partial fire alarm system integrity should a fault occur. A loop isolation device shall not exceed a maximum of 20 devices.
- viii. A maximum of 80% capacity of initiating devices is allowed per loop.
- ix. The fire alarm system shall use closed loop initiating device circuits with individual zone (device) supervision, individual notification appliance supervision, and primary and standby power supervision.
- x. Each device shall be labeled and the label designations shall be accurate and consistent with those on the prints, the annunciators, the points list, and message displays.
- xi. All devices, panels and auxiliary panels shall be mounted in easily accessible locations. The top of all panels shall be mounted no more than six (6) feet above finished floor.
- xii. The FACP will consist of a control center utilizing state of the art electronics with microprocessor-based technology and a minimum of four zone (loop) capability. The FACP shall be software controlled with the capability of owner programming. The installer will supply all programming data (complete program, data list) software and all updates to the software. Software media shall be Windows compatible using the most current version.

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

- xiii. The FACP shall have software capable of supervising Air Handler Unit (AHU) shutdown.
  - xiv. The FACP will have an audible device and separate LED's indicating ALARM, TROUBLE and SUPERVISORY conditions with each having a separate and distinguishable sound. The FACP shall have a backlit LCD display of at least three lines of at least 40 characters each. An indication of POWER, TROUBLE, and PARTIAL DISABLE shall be included as an LED output.
  - xv. The FACP equipment cabinet shall be of sufficient size to accommodate the main fire panel, main and standby power supplies (battery), cable and wire harnesses and any auxiliary relays.
  - xvi. Remote annunciators (if installed) shall have the same capabilities as the FACP in all respects unless otherwise directed by the AHJ.
  - xvii. There shall be a separate box located next to the FACP of sufficient size to accommodate spare detectors and paperwork (16" x 16" x 6" min.). This box shall be of matching color with the FACP cabinet and shall be keyed the same as the FACP.
  - xviii. Printer interface modules shall be installed in all systems.
- b. Programming Requirements
- i. Provide a "Drill Function" on the panel that is easily identifiable and only initiates notification appliances on all floors.
  - ii. Provide a Programmable "Bypass" function for:
    - 1. AHU shut down
    - 2. Elevator recall
    - 3. Stairwell pressurization fans
    - 4. Notification appliances
    - 5. Alarm verification
  - iii. Provides for all controlled systems to "auto reset," (i.e., AHUs and elevators)
  - iv. Provides for all system devices to be restorable from the FACP.
- c. Initiating Devices
- i. All water flow switches shall be time adjustable complying with NFPA 72.

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

- ii. Valve tamper switches shall comply with NFPA 72. A supervisory condition shall result from a tamper switch activation.
  - iii. Beam detectors shall:
    - 1. Comply with UL268
    - 2. Be 24vdc operation
    - 3. Have automatic contamination compensation
  - iv. Detector bases shall:
    - 1. Be low profile, surface, or flush mounted into a standard four inch square electrical box
    - 2. Be able to accept heat, ionization, or photoelectric devices interchangeably
  - v. Smoke detectors shall:
    - 1. Have an LED that flashes during normal operation
    - 2. Ionization detectors shall be dual chamber and be scaled against rear airflow
    - 3. Be self-adjusting for airborne contaminants
    - 4. Have clear, distinct visual alarm indication
    - 5. Be mounted in easily accessible locations
    - 6. Be programmed to have alarm verification
  - vi. Duct detectors shall:
    - 1. Report to FACP as a Supervisory Alarm
    - 2. Be of the photoelectric type
    - 3. Have clear, distinct visual power and alarm indications
    - 4. Be programmed to have alarm verification
    - 5. Have extended visual indicators if mounted above ceiling located as close to duct detector as possible
  - vii. Heat detectors shall:
    - 1. Be of the dual element, self-restoring type
    - 2. Have a flashing LED for normal operation
    - 3. Have clear, distinct visual alarm indication
  - viii. Manual pull stations shall:
    - 1. Be cast aluminum or high impact plastic and be red in color
    - 2. Be zoned separately if not addressable
    - 3. Provide a clear visual indication when activated
    - 4. Not require consumable parts to reset to normal condition
- d. Notification Appliances
- i. Audible devices:

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

1. Shall be tapped to an adequate wattage capable of achieving the minimum required dB reading throughout the facility
  2. Shall be tapped at the highest wattage in all mechanical rooms
  3. May be ceiling mounted speakers or combination devices where permitted to be installed by code
- ii. Visual devices:
1. May be ceiling mounted or combination devices where permitted by code

**VI. Installation, Testing, and Acceptance**

- a. The contractor shall have all devices on the system installed and the system pre-tested prior to the scheduled acceptance test.
- b. The contractor shall provide all tools, labor, and materials required for all installation start-up tests, including a qualified technician to conduct the test.
- c. Installation and testing shall be inspected and certified by a contractor supplied NICET II (minimum) Technician.
- d. System acceptance test shall be conducted in accordance with NFPA 72. See Annex C for TAMU acceptance test checklist.
  - i. Any deficiencies noted during acceptance testing shall be corrected within 14 calendar days and a retest shall be scheduled for all deficiencies noted if not corrected during the acceptance test.
  - ii. System acceptance shall be contingent upon approval by Environmental Health and Safety, Facilities Planning and Construction, and a Facilities Department representative.
  - iii. Upon completion of testing, the contractor shall install the proper certification certificates in the FACP and provide a copy of NFPA 72 Record of Completion and the FML-009 Form to Environmental Health and Safety.
  - iv. The contractor shall provide three (3) copies of drawings to be used during the acceptance test. These drawings shall reflect the installed device locations with device address on a floor plan representing the layout of the fire alarm system at the time of acceptance testing.

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

- v. The contractor shall supply an electronic copy of site specific software within 14 calendar days to the TAMU/TAMUS project manager per NFPA 72.

**VII. Warranty**

- a. The system shall be guaranteed to be free from all defects of material and workmanship for a period of one year, effective upon date of system acceptance.
- b. The contractor shall guarantee parts availability for a minimum of five (5) years after installation.



## **Annex A**

### **Design Submittal Requirements**

All preliminary and as-built design drawings and supporting documentation shall include: Floor plan drawings, riser diagrams, control unit wiring diagrams, point to point wiring diagrams, and typical wiring diagrams as described herein

- I. Name of owner and occupant
- II. Location, including street address
- III. Device legend
- IV. Date
- V. Input/output programming matrix
- VI. Licensed Designer Information – Registered Professional Engineer or Alarm Planning Superintendent (APS)
- VII. Battery calculations
- VIII. Notification appliance circuit voltage drop calculations
- IX. Floor Plan
  - a. Floor identification
  - b. Point of compass
  - c. Correct graphic scale
  - d. All walls and doors
  - e. All partitions extending to within 15 percent of ceiling height
  - f. Room descriptions
  - g. Fire alarm device/component locations
    - i. Signal notification devices
    - ii. Initiation devices
    - iii. Smoke control systems
    - iv. Initiation of automatic extinguishing equipment
    - v. Doors that unlock or close automatically
    - vi. Zone verification for detection devices
    - vii. Fire/Smoke damper control
    - viii. Fire alarm panel location
    - ix. Fire alarm annunciators
    - x. Control valves to Fire Protection System
    - xi. Duct smoke detectors
    - xii. Supervisory devices
    - xiii. Elevator location
    - xiv. Elevator recall system location
  - h. Location of fire alarm primary power connections
  - i. Location of monitor/control interfaces to other systems
  - j. Riser locations
  - k. Methods for compliance with 6.9.10.4 for survivability (emergency voice systems) as shown in section 6.9, where applicable
  - l. Ceiling height and ceiling construction details

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

- X. Fire alarm system riser diagram
  - a. General arrangement of the system, in building cross-section
  - b. Number of risers
  - c. Type and number of circuits in each riser
  - d. Type and number of fire alarm components/devices on each circuit, on each floor or level
- XI. Control unit wiring diagrams should be provided for all control equipment, power supplies, battery charges, and annunciators and should include the following:
- XII. Identification of control equipment depicted
- XIII. Location(s)
- XIV. All field wiring terminals and terminal identification
- XV. All indicators and Manual controls, including the full text of all labels
- XVI. All field connections to supervising station signaling equipment, releasing equipment, and fire safety control
- XVII. Typical Wiring diagram should be provided for all initiating devices, notification appliances, remote light emitting diodes (LEDs), remote test stations, and end-of-line and power supervisory devices.

## **Annex B**

### **Texas A&M University Fire Alarm Reporting System Interface**

All new fire alarm installations on the Texas A&M University campus shall be designed to interface directly with the dedicated fiber optics network. The network utilizes Siemens® technology to link all fire alarm systems on the campus and connect to a central monitoring station.

#### **I. General Requirements**

- A. Each new FAS installation requires a minimum ¾” conduit to be installed between the FACP and a fiber interface cabinet in the fiber network room.
- B. Wiring requirements
  - 1. Provide one (1) 18/2 shielded cable between the FACP and the fiber interface cabinet
  - 2. Provide one (1) 14/2 cable between the FACP and the fiber module in the fiber interface cabinet.

#### **II. Panel Specific Requirements**

- A. The following components are required for interfacing a Siemens XLS FACP to the campus FAS network
  - 1. NIC –C Network Interface Card
  - 2. RPM Remote Printer Interface (Provides the 485 Network)
  - 3. D2300CP OR D2325CPS (single mode module) Fiber Interface Module
- B. The following components are required for interfacing a Siemens MXL FACP to the campus FAS network
  - 1. NIM-1 Network Interface Card
  - 2. MOM-2 Mother Card for the NIM-1
  - 3. D2300CP OR D2325CPS (single mode module) Fiber Interface Module
- C. Specific components for other manufactures or Siemens panels must be verified with Siemens.

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

**Annex C**

**Texas A&M University**  
**Fire Alarm System Acceptance Checklist**

**Building #:** \_\_\_\_\_ **Building Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Attendees:** \_\_\_\_\_  
\_\_\_\_\_

|   |                              |                             |                              |
|---|------------------------------|-----------------------------|------------------------------|
| Functional test of all Smoke Detectors  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Heat Detectors   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Manual Pull Stations   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Duct Detectors   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Flow Switches  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Audio/Visual devices   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Magnetic Releases  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Remote Annunciators  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Fireman Phones   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Flow test of all Duct Detectors   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| dB level check on all Audible Devices   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Conduct Battery Discharge Test (30 Minutes) / Full Alarm Test (General - 5 Min./Emergency Voice 15 Min.)  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Verify That the Locations of All Power Supplies are Identified at FACP  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Functional test of all Relays<br><input type="checkbox"/> AHU Shutdown<br><input type="checkbox"/> Elevator Recall<br><input type="checkbox"/> Suppression Systems<br><input type="checkbox"/> Exhaust Fans<br><input type="checkbox"/> Pressurization Fans | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Verification of Trouble Alarms<br><input type="checkbox"/> Smoke Detector Circuit<br><input type="checkbox"/> A/V Circuit   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Verify all Supervisory Alarms<br><input type="checkbox"/> Sprinkler/Tamper<br><input type="checkbox"/> Duct Detector  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Verify Alarm, Supervisory, & Trouble Signals Received at Radio Room   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Verify Installation of Storage Box  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Sensitivity Test Printout Sent to Electronic Shop Personnel   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| O&M Manual transferred to Electronic Shop Personnel   | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Transfer of any special tools to Electronic Shop Personnel  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| FML-009 Form Completed and Transferred to EHSD  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| Other:  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

Comments: \_\_\_\_\_

**Design Criteria**  
**Division 28 – Electronic Safety and Security**

## General Information

### Site Clearing

Clear/grub/strip of trees, roots and vegetation that portion of the site to receive landscaping and improvements. Remove roots to a minimum depth of 24". No onsite burning is allowed unless approved by Owner. Trees/vegetation to remain shall be adequately fenced and otherwise protected from damage by construction operations.

If good friable top soil exists on site, strip this material to a depth of 4" and stockpile for reuse in areas to receive grass and other landscaping. Top soil to be free of significant vegetation, rocks or other deleterious materials.

### Topsoil

Topsoil shall be a natural, fertile, friable soil, possessing characteristics of representative productive soils in the vicinity. It shall be obtained from approved naturally well-drained areas. Only the top 12" (inches) of earth shall be removed and used. It shall not be excessively acid or alkaline or contain toxic substances, which may be harmful to the plant growth. Topsoil shall be without admixture of subsoil and shall contain a minimum of lumps, stones, stumps, roots, or similar substances 1" (inch) or more in diameter, quality to be determined by Physical Plant Department or its representative. Topsoil shall not be collected from sites that are infected with a growth of, or the reproductive parts of, noxious weeds (Nut Sedge, Johnson grass, and Bermuda grass). Topsoil shall not be stripped, collected, or deposited while wet. It is the responsibility of the Contractor to furnish the location where the topsoil is to be obtained to FPC Project Manager or its representative in writing, as well as a one gallon sample of such soil.

### Grading

Slopes of planted areas should allow easy maintenance. Turf areas shall have a slope of no more than 3:1 and no less than 1 percent. A 2 percent minimum slope is desirable. Areas with slopes greater than 3:1 must be planted with ground cover and constructed to control erosion.

Existing trees and other plant material to be preserved shall be indicated on the grading plan. Where trees are to be preserved no grading or paving of the existing grade within the drip line is allowed.

Slopes for walkways shall comply with Texas Accessibility Standards

Compact per the requirements of the Geotechnical Engineer or as a minimum compact the top 6" of all subgrade to receive embankment or paving/structural improvements to a minimum of 95% maximum density as per ASTM D-698. Open area embankment shall

be placed in maximum 12" lifts and compacted to a minimum of 90% maximum density as per ASTM D-698.

Structural embankment shall be compacted per the requirements of the Geotechnical Engineer or as a minimum compact in maximum 8" lifts to a minimum of 95% ASTM D-698 . Backfill around structures shall be placed uniformly and only after the elements of the structure have attained the required strength to resist the soil pressure.

Select fill where required shall be a material available in the general area of the project (if possible) having a plasticity index (PI) ranging from 7 to 15, a liquid limit of 35 or less and being free from organic matter, large rocks or other deleterious materials.

### **Excavation, Trenching and Backfilling for Utilities**

Excavation/trenching and backfilling operation shall be coordinated such that no more than 200 linear feet of trench is open at any one time. Backfilling is to be scheduled so there is a minimum amount of open excavation left during hours of no work. All open excavation shall be properly lighted and barricaded during hours that contractor is not on site. The open ends of all utility lines shall be temporarily sealed at the end of the working day.

Adequate measures shall be taken to prevent runoff water from entering the trench without damage to surrounding facilities/properties.

De-watering systems shall be provided as required for excavation/backfill activities and to allow installation of utility lines and embedment envelope on dry stable trench bottom. Discharge from the de-watering system shall be directed to drainage facilities of adequate capacity in a manner that will not damage or interfere with the use of adjoining facilities/properties. De-watering systems shall be provided at no additional cost to the Owner.

The embedment zone for a utility line extends from 6" below the bottom of a utility line to 12" above its top. Embedment material for water and sanitary sewer PVC lines shall be clean sand. Embedment material for storm sewer RCP lines is fine gradation gravel with maximum diameter of 3/4". Embedment material for pre-insulated thermal utility piping is sharp sand. Electrical duct bank is typically encased in red concrete and installed on the undisturbed trench bottom. High water table elevations may necessitate the use of an alternate embedment material and different embedment zone dimensions.

Backfill above the embedment zone for trenches in open areas shall be native material compacted in maximum 12" lifts to 90% maximum density as per ASTM D-698. Backfill above the embedment zone for trenches in areas under existing or proposed pavement or ground supported structures shall be cement stabilized sand (1 ½ sacks of cement per cubic yard of sand) compacted in maximum 8" lifts. Consolidation of trench backfill by flooding/jetting is not allowed.



An excavation/trench safety program shall be implemented which complies with OSHA trench safety standards, Subpart P. A trench safety plan shall be prepared and sealed by a Texas Professional Engineer and submitted to the Owner prior to the start of construction.

### **Lime Stabilization**

If lime stabilization is required, refer to Division 32, Site Paving section.

### **Termite Treatment**

When soil treatment is required all products used for the treatment of termites shall display labels bearing Environmental Protection Agency approvals and shall be mixed and applied in accordance with directions on the label.

### **Void Space Below Grade Beams**

Provide soil retainers at face of grade beams below grade to form a void of sufficient depth to prevent expansion of earth to cause pressure on bottom of beams. Acceptable product is SureRetainer by MotzBlock.



## **General Information**

### **Site Paving**

Site paving shall be provided to facilitate pedestrian and vehicular access along with emergency and service vehicle access to the site and facility being designed.

Materials, parameters and methods shall be in basic conformance with the TxDOT “Standard Specifications for Construction of Highways, Streets and Bridges,” latest edition and applicable ASTM standards.

Subgrade material to receive pavement sections other than pedestrian sidewalks which has a plasticity index (PI) greater than 17 shall be stabilized in place with lime prior to placing the pavement. Lime shall be placed in slurry form or with Owner approval, lime may also be dry placed as Type C pelletized quicklime (grade DS). Lime shall be thoroughly mixed into the subgrade with a rotary pulverizing mixer using a two step preliminary mix/final mix procedure with appropriate curing times between mixes and compaction before opening to traffic or placing additional courses. Subgrade material to receive pavement sections other than pedestrian sidewalks which has a plasticity index (PI) less than 5 shall be stabilized in place with Type I Portland cement. The cement shall be dry mixed into the subgrade using a rotary pulverizing mixer, appropriate water added and then thoroughly mixed with the cement and soil until a full depth uniform mix has been obtained. Appropriate compaction and moist curing shall occur prior to placing additional courses. Stabilized subgrade shall be compacted to the requirements of the Geotechnical Engineer or to a minimum of 95% of the maximum density as per ASTM D-698 . Stabilized subgrade shall extend a minimum of 12" beyond the supported pavement section. The amount of lime or cement to be added to the subgrade and the depth of stabilization shall be determined by the geotechnical consultant based on design mix tests and anticipated traffic loadings.

Pavement sections subject to vehicular traffic shall be either a rigid section of portland cement reinforced concrete (PCRC) or a flexible section consisting of hot mix asphaltic concrete (HMAC) surface over an approved flexible base material (coordinate pavement type selection with Owner). PCRC pavement sections shall be a minimum of 6" thick. Finish shall be broom or burlap drag. HMAC shall be Type “D” and the flexible base material shall be Type A, grade 1 or 2 as defined in the TxDOT standard specifications. A rolling pattern for HMAC shall be established using a Troxler Nuclear Density Gauge. The flexible base shall be compacted in maximum 8" lifts to a minimum density of 95% of the maximum density as per ASTM D-1557 and shall be primed with approved asphaltic material at a rate established by the team and shown on the plans prior to HMAC placement. The HMAC surface course shall be compacted to contain 3 to 8 percent air voids when tested in accordance with Tex-207-F and Tex-227-F.

The thickness of the pavement section elements shall be recommended by the geotechnical engineer based on soil conditions and anticipated traffic loadings.

## Design Criteria Division 32 – Exterior Improvements

Pavement at trash dumpsters, loading docks, etc. subject to heavy vehicular maneuvering and turning shall be PCRC.

Pedestrian sidewalks shall be PCRC with a minimum thickness of 4" and a minimum width of 4'. Pedestrian sidewalks that may also be service and/or emergency vehicle pathways shall be a minimum of 6" thick and appropriate width. The finish shall typically be a light broom finish but shall be coordinated with any campus standard finish schemes. Sidewalks shall be cross-sloped (max. 2%) in the direction of site drainage patterns. Sidewalks adjoining concrete curb and gutter shall be doweled into the curb and gutter section. Sidewalks adjoining foundations at doors and other points of pedestrian circulation shall be doweled to the foundation in a manner to prevent differential movement.

Concrete pavement shall typically be edged with a 6" concrete curb. Preferably the curb shall be poured monolithically with the pavement but doweled curb sections are allowed. If poured separately the curb section shall be recessed 1" into the pavement and attached with dowels of sufficient spacing and length to hold the curb firmly to the pavement.

HMAC flexible pavement sections shall typically be edged by reinforced concrete curb and gutter to receive storm drainage from the pavement and to stabilize the pavement edge. Place doweled expansion joints in curb and gutter as a minimum at end of radius returns, at curb inlets and at maximum 40' centers in straight runs. Expansion joints in curbs with adjoining sidewalks shall match the joint location and spacing in the sidewalk. Contraction joints a minimum depth of 3/4" or 1/4 slab depth whichever is greater shall be placed at 10' intervals. Curb and gutter section shall be placed on 4" of flexible base material compacted to the same requirements as the pavement section.

Reinforced concrete valley gutters shall be placed in areas of concentrated storm water runoff across HMAC pavement such as at street/driveway intersections. The valley gutter section shall be placed on 4" of flexible base material compacted to the same density requirements as the pavement section. Doweled expansion joints shall be placed in valley gutters at maximum 40' centers.

All pavement/surfaces and gutters shall be crowned and/or sloped sufficiently to positively direct storm runoff to points of discharge or collection as to eliminate "birdbaths". Minimum cross slopes for open pavement areas shall be 1%; minimum crown for streets shall be 6" above the gutter line; minimum slopes for curb and gutter shall be 0.5%.

A jointing plan shall be prepared as part of the design plans showing the type and location of joints in all PCRC pavements including sidewalks and curbs/valley gutters. The expansion joints in sidewalks shall be placed at walk intersections and at maximum 20' centers in straight runs. Expansion joints, contraction joints, construction joints and isolation joints shall be placed in accordance with good engineering practice as required

## Design Criteria Division 32 – Exterior Improvements

to control cracking and other distress in the concrete pavement and to facilitate construction. Concrete sawn joints shall be cut “green” using the “soft saw cut technique” as soon as the concrete hardens to support the weight of an early entry type concrete saw and operator to avoid raveling.

Concrete for all site paving/curbs/gutters shall have a minimum compressive strength of 3,000 psi at 28 days. Reinforcement shall be new deformed steel bars conforming to ASTM A615, Grade 60 minimum No. 4 bar in size. No welded wire fabric shall be used as reinforcement except in unique situations as approved by Owner. All concrete shall be adequately cured by protecting it against moisture loss for a period of not less than 72 hours beginning immediately upon completion of finishing operations and initial set of concrete.

Expansion joints shall consist of smooth bar dowel assemblies conforming to ASTM A615, grade 60 with a PVC sheath over the free end, asphalt impregnated fiber board filler and cold applied self leveling polyurethane sealant with closed cell polyethylene backer rod.

The basic configuration of parking lots shall be as follows:

|                |   |
|----------------|---|
| Parking Angle: | 90 degrees  |
| Stall Width:   | 9' - 0"   |
| Module Width:  | 62' - 0" (stripe to stripe), 60' - 0" (face of curb to stripe), 58' - 0" (face of curb to face of curb) |
| Drive Aisle:   | 24' - 0"  |
| Stripe Width:  | 4"  |
| Stripe Length: | 18' - 0"  |
| Stripe Colors: | White for general parking. Yellow for no parking, and loading.<br>Blue for accessible.                  |

|                     |   |
|---------------------|---|
| Landscaped Medians: | Planted with low profile vegetation, irrigated, and spaced appropriate to the design. |
|---------------------|---|

|                      |  |
|----------------------|--|
| Concrete Mow Strips: | 2'-0" wide back of curb for head-in parking when no wheel stops are provided |
|----------------------|--|

|           |                  |
|-----------|------------------|
| Lighting: | 0.9 foot candles |
|-----------|------------------|

### Concrete Walks

Concrete sidewalks width shall be sized to handle pedestrian flow.

Concrete sidewalks are generally medium broom finish.

Avoid surface drainage of storm water across sidewalks.

## **Bicycle Racks**

Show bicycle racks in sufficient quantity near but not in front of entrances. Use standard ribbon hot dipped galvanized pipe type embedded in concrete.

These details shall be incorporated in the drawings. The number of racks required will be determined during the schematic design stage with the FPC Project Manager.

## **Trash Removal**

Trash receptacle location should be at grade level and should be placed so that they can be loaded from top as well as side and screened from public view. Verify method of disposal at various research centers/stations and other Universities.

Receptacle area should be adequately lighted for night use.

At dumpster locations, provide a concrete pad of sufficient size and strength to accommodate the dumpster and truck.

## **Porches and Steps**

All stoops, porches, docks and steps, exterior and interior should have built-in abrasive surfaces. Slope exterior porches and treads to drain water 1/4" per foot. Exposed concrete finished work shall be accomplished in two pours: the first structural and the second being a two inch minimum finish topping poured near completion of project. WTAMU prefers a single pour system, to avoid potential freeze thaw damage. Primary entry floors may be constructed using brick, tile, pavers or other permanent floor materials.

## **Landscaping**

All landscaping plantings shall be planned and designed to be compatible with the overall campus landscaping scheme. Emphasis shall be placed on durability and low maintenance characteristics.

Planting Mixture- Premixed blend of topsoil, organic matter, and sand in a ratio suited for the area and plant material specified. Seasonal color beds shall have 2" depth of peat moss tilled into top layer of planting mix before installation of plant material.

Planters- 12" Minimum of planting mix placed in planter. Crown surface for drainage.

Turf Areas- 3-4" of topsoil placed and fine graded before placement of turf.

Concrete Mow Strip- Planter areas that are adjacent to turf areas shall have a 12" wide

## Design Criteria Division 32 – Exterior Improvements

x 4” thick, reinforced concrete mow strip. Reinforcing shall be No. 3 rebar. Medium broom finish. Concrete shall be 5 sack mix, 3000 PSI at 28 days, minimum. Adjacent to building the mow strip shall be minimum 24” wide with an expansion joint and not doweled to the building foundation.

All disturbed areas shall be graded to properly drain and seeded or sodded with a permanent grass.

Sod- Sod shall be variety approved by the campus representative.

Sod shall be composed of certified, approved, or nursery grown grass and shall be true to name/variety. Sod shall be substantially free of noxious weeds, disease, insects, thatch and undesirable grasses. Sod shall have a sufficient density so that no surface soil is visible at a mowing height of 1.5 “(inches). Sod shall be neatly mowed and mature enough that when grasped at one end it can be lifted and handled without damage to the sod. Maximum mowing height shall be 2.5 “(inches).

Sod shall be cut to provide a sufficient root zone and stand of live grass. Sod shall be cut with a uniform soil portion of a ½” thickness, plus or minus ¼ inches.

Sod shall be cut, delivered and installed within 24 hours of cutting. Sod shall be cut by mechanical means such as sod cutters. Sod shall be cut when the moisture content (either excessively wet or dry) will effect the lifespan of the sod.

Area to designated for sod, shall fine graded, smoothed, with topsoil placed before final grading. If soil is dry, lightly moisten before placement of sod.

First row of sod shall be placed in straight line with additional placement of rows shall be parallel and tightly placed against each row. Staggered lateral joints butted tightly shall be used. Sod shall not be stretched or overlapped.

Sod on slopes greater than 3:1 shall be placed perpendicular to slope. Sod on slopes shall be temporally fastened to ground by stakes, staples, pegs or other approved methods. After sod has become established, contractor shall remove fasteners.

Sod shall be lightly rolled after section is placed. Once sod has been placed, immediately water sod to prevent excessive drying. Thoroughly water sod so that underside of sod and soil are completely wet.

### **Irrigation**

Design and installation must meet TCEQ (Texas Commission on Environmental Quality) irrigation laws and requirements. Irrigation systems shall be installed under the supervision of a Licensed Irrigator.

The irrigation system shall be positively separated from the domestic water system by a

## Design Criteria Division 32 – Exterior Improvements

double check or reduced pressure type backflow preventer meeting the requirements of AWWA C506. Type chosen shall be suitable to the installation location and conditions. Backflow preventers may be placed in the mechanical space of the building when appropriate. Double check valve backflow preventers located in the landscape, when placed underground shall be in valve boxes or vaults with adequate room for testing. Backflow preventers placed above ground, should be located to minimize visibility, and or concealed with plants or landscaping features to maintain aesthetics.

Enclose pipe and wiring beneath roadways, walks, curbs, etc., in sleeves. Extend sleeve ends 24" beyond the edge of paved surface. Mark sleeve location with 3/8" X 3" brass or stainless steel stove bolt embedded in the concrete at each end. Sleeving pipe beneath pedestrian pavements shall be PVC Class 200 with solvent welded joints. Sleeving pipe beneath drives and streets shall be Schedule 40 with solvent welded joints. Sleeves installed under pavement for future irrigation installation shall be loose capped on each end and marked with stove bolts as above. Size and depth of sleeve should be coordinated with the landscape architect, with a minimum size being 4".

Mainline and lateral pipe shall be PVC Class 200 and have bell ends. Mainline and lateral fittings shall be PVC Schedule 40. All PVC pipe and slip fittings shall be joined with primer and solvent cement. Cure time for cement should be in accordance with manufacturer's instructions. For threaded PVC connections, use only Teflon-type tape. When connection is PVC to metal, the PVC component shall have male threads and the metal component shall have female threads.

The satellite irrigation controllers should be located outside the building or as directed by the Facilities Department. Controller units shall be compatible with the existing campus controller system. For controller, provide quick disconnect from power source next to controller.

Electric wire from the satellite controller to each remote control valve and the common wire shall be AWG No. 14 solid copper, type UF cable, UL approved for direct underground burial. Wire color should be continuous over its entire length. Use white for common ground wire. Use easily distinguishable colors for other control wires. Control wire splices shall be made with 3M-DBY or equal direct burial splice kit. If multiple splices are made in one location, splices are to be placed in a valve box. Install a control wire from controller to each remote control valve. Multiple valves on a single control wire are not permitted. Control wires shall be in same trench as constant pressure lines. Provide an isolation valve for each zone; however, it is acceptable to install 2 zones to an isolation valve if necessary. Remote control valves shall be placed in valve boxes.

Remote control valves and irrigation heads should be compatible with existing campus irrigation system. Head to head spacing is required. Spacing must not exceed manufacturer's recommended spacing. All heads shall be adjusted to factory specifications.



Excavated material is generally satisfactory for backfill. Backfill shall be free from rubbish, vegetation, frozen materials, and stones larger than 2 inches in dimension. Backfill placed next to pipe shall be free of sharp objects which may damage the pipe. Contractor shall be responsible for adding soil to trenches after settling has occurred.

Upon completion of work, remove from the site all tools, excess materials, and rubbish.

Contractor shall provide a demonstration and walk through of entire irrigation system with Owner and Owner's Representative.

Contractor shall supply record drawings ("as built") of all irrigation as installed in ground to Owner or Owner's representative. Zones, back flow preventer, and controllers as well as the zone flow measurement for each zone shall be included and shown on the drawings. Drawings shall be at a scale no smaller than one inch equals thirty feet. Drawings shall be sealed, dated and signed by licensed irrigator in the State of Texas. Operation manuals for controller and other irrigation equipment shall be submitted at time of record drawings.

## **Campus Specific Information**

### **Texas A&M University**

#### **Trash Removal**

Front loading trucks used at TAMU and TAMUG.

#### **Irrigation Materials**

Spray Heads - Up to 17' Radius, Lawn and Shrub Areas  
Toro 570 Series with pressure compensating device (PCD)  
Shrub heads shall be 6" or 12" Hi-Pop Body. Turf areas shall be 4" Hi-Pop Body.

Rotary Heads-  
Hunter PGP  
Hunter I-40

Electric Control Valves  
Rainbird PEB Series

Gate Valves- Brass  
Ball Valves - PVC

Quick Coupling Valves  
Rainbird #44

Back Flow Preventer-  
Double Check Valve  
½” to 2” Febco 805Y or equal  
2 ½” and greater Febco 850 or equal

Fittings-  
Lasco or equal

Wire-Direct Burial Wire  
Connectors- 3M – DBY or equal

Valve Boxes-  
AMTEK or Equal

Plant Materials

Trees

|                              |                            |
|------------------------------|----------------------------|
| Texas Red Oak                | Crepe Myrtle               |
| Shumard Oak (non irrigation) | Aristocrat Pear            |
| White Oak                    | Mexican Plum               |
| Bur Oak                      | Texas Pistache             |
| Easter Red Cedar             | Chinese Pistache           |
| Nuttall Oak                  | Golden Rain Tree           |
| Live Oak                     | Texas Ash                  |
| Monterrey Oak                | Texas Persimmon            |
| Cedar Elm                    | Texas Redbud               |
| Pecan                        | Mexican Redbud             |
| Chinese Elm                  | Elderica Pine              |
| Bald Cypress                 | Bradford Pear              |
| Pond Cypress                 | Western Soapberry          |
| Monterrey Cypress            | Japanese Yew (by building) |
| Texas Mountain Laurel        |                            |

Shrubs

Indian Hawthorn  
Dwarf Yaupon  
Dwarf Burford Holly  
Burford Holly  
Green Texas Sage  
Sliver Texas Sage

Mediland Rose  
Knock Out Roxe  
Oleander  
Dwarf Chinese Holly  
Chinese Photinia

#### Groundcover

|                       |                  |
|-----------------------|------------------|
| Liriope               | Creeping Lantana |
| Big Blue              | Lantana          |
| Silvery Sunproof      |                  |
| Liriope Spicata       |                  |
| Sliver Dragon         |                  |
| Giantea               |                  |
| Asiatic Jasmine       |                  |
| Dwarf Asiatic Jasmine |                  |
| Confederate Jasmine   |                  |
| Carolina Jessamine    |                  |
| Creeping Euonymus     |                  |

### Tarleton State University

#### Site Furnishings

**Public Areas Benches-** The Public area benches shall be constructed of all weather Pea Gravel aggregate stone sides with Powder coated Bronze preferred colored expanded fluted metal Seating and back rest. The expanded metal should be fluted/slotted style for public areas only. Final aggregate color to be coffee Bean (see [www.upbeat.com](http://www.upbeat.com) for examples. Item# CKSCBEN6) Public areas would be defined as the Thompson Student Development Building, The Administration Building, The Trogon House, Fine Arts Building, Mall areas, Band Stand, Military Memorial, visitor Center...ect..

**Trash Receptacles** aggregate and slotted metal should match the public area benches as well. Available colors are Black or Brown (bronze preferred if available) metal color should match with the bench color as well. (see [www.upbeat.com](http://www.upbeat.com) for examples. Item# TSS) Aggregate color to be coffee bean.

**Intermediate Campus area Benches - 6' wide metal slotted bench with Cast iron ends Item # L1360 Bronze color** The Intermediate area benches shall be constructed of Cast Iron ends with plastisol coated steel rectangular steel slats with high gloss powder coat finish. These benches should be utilized throughout the general areas of campus. (not in highly public areas or off the beaten path )

These would be installed in and around front entrances the general classroom type buildings such as the O.A Grant Building, The Math Building, The business Building, ect.. (see [www.upbeat.com](http://www.upbeat.com) for examples. **Item# L1360**)

**General Campus 5' wide metal bench** (Lower cost General campus bench) Item # L2010 The general area benches shall be constructed of rectangular steel tubing with high gloss powder coat finish. These benches should be utilized throughout the general off the beaten path type areas of the campus. (not in highly public areas or up against the main entrances areas of building. These benches will make great sidewalk pathway benches as well as backsides of buildings not regularly utilized by the public. (see [www.upbeat.com](http://www.upbeat.com) for examples. **Item# L2010**)

**Trash Receptacle 32 gallon** (see [www.upbeat.com](http://www.upbeat.com) for examples. Item# L1378) This trash receptacle is constructed of Plasticol coated steel slats. Color Bronze Lid shall be see [www.upbeat.com](http://www.upbeat.com) item# #3202 bronze color.  
(Note: This Trash receptacle shall be used with all the benches except “Public area benches” which have aggregate sides).

## **Prairie View A&M University**

### **Concrete Walks**

Concrete sidewalks on the Prairie View A&M University campus should make maximum use of exposed aggregate finishes such as in the quadrangle landscape area.

## **Texas A&M University-Kingsville**

### **Trash Removal**

Side loading trucks are used at Texas A&M University-Kingsville

## **West Texas A&M University**

### **Trash Removal**

Rear loading trucks are used at WTAMU, there are no dumpsters.

## **General Information**

All connections to campus utility distribution systems or public utilities shall be accurately located by dimensions or coordinates. Depth of piping shall be shown and inverts must be shown at manholes and other critical points.

All site utilities shall be included as part of the BIM(s). They shall be shown accurately in terms of size, depth, and location.

## **Sanitary Sewerage Utilities**

Gravity sanitary sewer mainlines shall be no less than 6" and services lines shall be no less than 4". All gravity sanitary sewer piping shall be SDR 26 PVC (ASTM D 3034) or heavier. Exposed piping shall be ductile iron with appropriate coating protection. PVC and ductile iron piping shall have watertight push-on joints using elastomeric gaskets meeting the requirements of ASTM F 477 and AWWA C111 respectively. Fittings shall be of equal strength as the piping. Appropriately spiced and terminated tracer wire or aluminum tape shall be laid with all non-metallic sewer piping.

Manholes are required for all horizontal and vertical bends as well as changes in pipe size. Manholes on sanitary sewer mainlines shall be spaced no further than 350 feet apart and be placed at all piping intersections and angle points with the exception of 4" service lines. Appropriate wye fittings shall be used at such service connections. Sanitary sewer manholes shall be either cast-in-place or pre-cast (ASTM C478)) with a reinforced concrete base. Minimum 28 day concrete strength shall be 3,000 psi. Manholes shall be placed on 9" of 1-1/2 sack cement stabilized sand. The invert of the manhole shall be sloped and smooth finished sufficiently to prevent deposition of solids. If the elevation difference between an entering pipe and the exiting pipe is more than 2 feet, a drop type connection to the manhole shall be used. Manhole construction and testing shall be in accordance with TCEQ requirements.

Sanitary sewer and storm sewer shall be shown on separate sheets along with profiles.

All pipes penetrating exterior walls or foundations of buildings below grade must be installed properly with sleeves to prevent breakage due to building settlement or expansive soil.

Provide 30 inch diameter minimum size access openings for all sanitary manholes.

Cleanouts shall be provided for all service laterals and be located at the building and at each bend. Cleanouts shall be installed on all 4" sanitary sewer service lines as required to facilitate line cleaning.

Profiles on sewer lines shall be shown for all pipe sizes. The profiles shall show as a minimum, depth of cover, other utility crossings with verified elevations, slope, inverts,

pipe material and class of pipe.

Sanitary sewer lift stations shall consist of precast (ASTM C478) or cast-in place reinforced concrete wet well containing a heavy-duty duplex pumping system readily accessible/removable for replacement/maintenance. A lockable hatch system of adequate size for maintenance/access shall be provided. A reliable level control system shall be provided to start/stop the pumps including a high level alarm. The basic control system shall consist of a remote disconnect, combination starter for each motor, H-O-A switches, visual and audible high level alarm, run lights and seal failure sensors. All Conduit connections to the wet well will be adequately sealed to sewer gases/moisture. Pump discharge piping for each pump shall be flanged ductile iron containing a check valve and plug valve located in a valve pit exterior to the wet well. Metal surfaces inside the wet well and the inside surfaces of the wet well shall be protected by appropriate coatings. Valve pit shall have a lockable hatch of adequate size for operation and maintenance of valves.

Sanitary sewer force mains shall be SDR 21 PVC complying with ASTM D2241. All fittings shall be of equal Class and pressure rating as pipe. All angles, bends, tees, etc. shall be stabilized with concrete thrust blocks, sized by the Project A/E. All non-metallic force mains shall have aluminum detector tape 12" placed below final grade.

The sanitary sewer system shall be designed, installed and tested in accordance with Texas Commission on Environmental Quality (TCEQ) requirements. Leakage test on PVC pipe shall be a low pressure air test performed as set forth by the Uni-Bell PVC Pipe Association. Deflection tests shall be by a mandrel pulled 30 days following trench backfill. All tests shall be witnessed by the Owner.

### **Storm Drainage Utilities**

Storm sewer shall either be RCP Class III (ASTM C76) for 12" and above or SDR 26 PVC (ASTM D3034) or heavier for less than 12". RCP joints shall meet ASTM C443. PVC pipe shall have water tight push-on joints meeting the requirements of ASTM F477.

Storm roof drains shall be run separately from all other storm water sources to the outside of the building.

Both sanitary and storm sewers sizes shall be determined by a Texas Professional Engineer (PE) and is to be based on existing/future sewer capacities and a drainage study for storm sewers. If the existing infrastructure cannot accommodate the increased loads, then an estimate shall be presented to the Owner to determine if additional funds need to be appropriated for any up-sizing.

Manholes and/or junction boxes with access openings shall be installed on the storm sewer system at all piping intersections, changes in slope and angle points with the exception of small drain leads which may use appropriate wye fittings. Manholes shall

be either pre-cast (ASTM C 478) or cast-in-place with a reinforced concrete foundation. Junction boxes shall be of reinforced pre-cast or cast-in-place construction. Minimum 28 day concrete strength shall be 3,000 psi. Foundation for manholes and/or junction boxes shall be on 1-1/2 sack cement stabilized sand.

Provide 30 inch diameter minimum size access openings for all manholes. Iron castings for manhole rings and covers shall conform to ASTM A 48, Class 30 and be traffic rated.

Area inlets for the storm sewer system shall be either pre-cast or cast-in-place reinforced concrete with frame and grate iron castings conforming to ASTM A48 Class 30 and shall be traffic rated. Curb inlets shall also be either pre-cast or cast-in-place with a manhole frame and cover installed in the top to allow access. In high visibility areas near buildings or at pedestrian drop off points, inlet tops shall be cast-in-place. Minimum concrete 28 day compressive strength for inlets shall be 3,000 psi. Typically storm sewer discharge points shall be stabilized with either a pre-cast or cast-in-place headwall structure with adequate surrounding rip-rap to control erosion. Minimum concrete 28 day compressive strength for headwalls shall be 3,000 psi.

## **Water Utilities**

The domestic water system shall be designed and installed in accordance with TCEQ requirements.

Domestic water piping 4" to 12" shall be AWWA C-900 or AWWA C-909, Class 200 PVC with elastomeric gasketed push-on joints. Domestic water piping larger than 12" shall be AWWA C-905, Class 200 PVC with elastomeric gasketed push-on joints. Fittings shall be cement mortar lined and appropriately coated and protected mechanical joint ductile iron. Piping smaller than 4" shall be SDR 21 Class 200 ASTM D2241, PVC with elastomeric gasketed push on joints. Fittings shall be PVC of equal strength.

All angles, bends, tees etc. shall be stabilized with concrete thrust blocks sized by the Project A/E. Appropriately spliced and terminated tracer wire or aluminum tape shall be laid with all non metallic water line.

Line valves shall be placed at all points of connection to existing water lines, at branch intersections and any other location necessary for adequate control of the water system. Typically the number of valves at an intersection will equal the number of branches less one. "In line" valves shall be placed in long runs of pipe at approximate 2000 foot spacing. Adequately supported air/vacuum relief valves shall be installed as required along the main in enclosures to facilitate draining and maintenance/inspection.

Line valves 3" and larger shall be direct bury resilient wedge gate valves meeting the requirements of AWWA C509 with mechanical joint connectors and non rising stem nut operator. Valves shall be poly wrapped in accordance with AWWA C105. All valve operators shall open when turned counterclockwise and close when turned clockwise.

Line valves smaller than 3" shall be bronze body ball valves with threaded connectors, stainless steel ball and stem, lever operated with a rated working pressure of 200 psi.

Cast iron adjustable valve boxes with surface reinforced concrete collar shall provided over all buried valves to provide access from ground surface to valve operating nut.

Adequate fire hydrants shall be placed around the facility such that no portion of the building is over 300 feet from a hydrant. Fire hydrants shall be 5 1/4" main valve opening with 2 ~ 2-1/2" hose nozzles and a 4 1/2" pumper nozzle. Coordinate nozzle size and thread requirements with entity providing fire protection. Hydrants shall be dry-top compression type hydrants, traffic model, complying with AWWA C502. Auxiliary gate valves shall be placed in all hydrant leads.

Where necessary, connections to existing water mains shall be a "hot" tap using a tapping sleeve and valve appropriate to the type of pipe being tapped. No full size taps shall be made without approval by the Owner.

The domestic water supply to a facility shall be metered unless directed otherwise by the Owner.

The complete site domestic water system installed for the project shall be pressure tested for leakage in accordance with TCEQ requirements along with applicable fire protection codes and shall be disinfected in accordance with the requirements of AWWA C601.

All waterlines shall have an aluminum detector tape placed 12" below final grade.

### **Concrete Utility Boxes**

Concrete boxes required by the mechanical, plumbing, civil site work and/or electrical divisions must be properly dimensioned, reinforced and/or detailed.

Chilled water and heating water valves in underground systems shall have as an enclosure a concrete valve box with sufficient space to maintain and operate valves. Direct buried valves may be considered if acceptable to the System Mechanical Engineer.

### **Chilled and Heating Water Distribution**

Chilled water and heating water distribution piping shall be pre-insulated ductile iron. All straight section shall be factory insulated. Fittings and joints shall be provided with field insulation kits compatible with the factory insulation. The insulation shall be protected by an HDPE outer shell. Pipe shall be listed suitable for use with 43 degree chiller water and 180 degree heating water. Ductile iron pipe shall be Class 50 thickness, restrained joint conforming to ANSI A 21.512 or AWWA C 151-75. Pipe and



fittings shall be cement lined and have an external bitumastic/tar coating and no internal coating. Pipe and fittings shall be U.S. Pipe TR FLEX or Clow Super Lok.

Spacing between chilled and heating pipes should be at least 10 – 12 inches.

Direct burial of steam piping is not acceptable. Some form of concrete or metal duct shall be provided.

Use Cor-ten© bolts or corrosion resistant alloy bolts on underground piping especially heating water piping.

All underground direct buried valves shall be ductile iron butterfly with a "Ground Hog" gear box.

## **Electrical Distribution**

### **Underground Ductbanks**

Outside the perimeter of buildings, install underground medium-voltage conductors in red-colored, concrete-encased, steel-reinforced ductbanks with not less than 3 inches concrete coverage and 1.5 inches between adjacent ducts.

Specify red-dyed concrete for medium-voltage ductbank embedment. Dye shall consist of red ferrous-oxide concrete coloring pigment mixed at the rate of two pounds per sack of cement.

Minimum duct trade size:

- Low-Voltage (0 - 1000 V): 2 inches
- Medium-Voltage (1001V - 69kV): 6 inches

Specify duct material to be Schedule 40 polyvinyl chloride (PVC).

Design ductbanks and manhole systems to slope a minimum of 3 inches per 100 feet to a suitable sump in a manhole.

Design ductbanks to provide a minimum cover of 30 inches from the ground surface to the top of the concrete.

For new power ductbank installations, provide 33% spare ducts, rounding all fractions up to the next whole number, but not less than one spare duct.

For projects involving addition of cable(s) to an existing ductbank, provide a new duct run along the same route if the installation will fill the only remaining open duct(s). Provide a minimum of two new spare ducts. *A fault in a ductbank frequently results in the faulted cable adhering to the walls of the duct, very difficult or impossible to remove.*

Install underground warning tape below grade and above all ductbanks marked “BURIED ELECTRIC LINE.” Warning tape shall be metallic (detectable) or contain a detection strip integral to the tape material.

## **Power Manholes**

Provide precast concrete manholes dedicated to the campus medium-voltage utility and distribution system. Include all standard hardware and accessories.

Provide precast manholes for all site medium voltage power distribution. The maximum allowed spacing is 400 feet and at all 90° horizontal changes in direction.

Medium-voltage manholes used for the distribution of power shall have nominal dimensions of 8-ft high X 10-ft long X 8-ft wide to accommodate the space required for pulling, bending, wrapping, and supporting the largest shielded MV105 cables required for a 600A main feeder circuit consisting of 3-500kcmil conductors plus a 600V-rated 2 AWG grounding conductor, in addition to the largest submersible medium-voltage switch that may be installed (a unit with 5 switched-ways each rated at 600A).

Standard hardware and accessories for power manholes include:

- Thin-wall knock-outs on every wall
- Ladder with skid-resistant rungs anchored to floor and wall
- H-20 rated manhole ring and cover
- Sump pit & pump
- “Ladder Up” safety post
- All metal parts bonded to ground rod
- Cable racks
- Pull irons

All existing manholes must be kept accessible at all times during construction.

## **Data/Telecomm Distribution**

The contractor shall furnish and install a telecommunications ductbank consisting of 4 four inch conduits surrounded by reinforced concrete similar to the 12KV ductbanks except the concrete shall not be dyed red. This duct bank shall include a No. 2/10 bare ground wire cast inside the concrete envelope. The duct bank shall run from the building’s main telecom room (MDF room) to the Owner designated telecom manhole. Sand shall not be used as a backfill.

## **Site Lighting**

All roadways, parking lots and pedestrian ways, shall be illuminated during the hours of

darkness. Bollards and building mounted flood lights shall not be used. Form cast concrete poles shall not be used. All site and exterior lighting shall use campus standard lamps. All site lighting fixtures and poles shall be in accordance with the campus standard fixtures.

Site lighting shall be controlled through a mechanically held contactor using photo cell off and on with a hand-off-auto (HOA) switch override. All site lighting fixtures shall be individually fused at each pole. Each pole shall be grounded with a 3/4" x 10' ground rod.

### **Site telephones**

Provide at least two exterior emergency telephones. Each location shall be ADA accessible. Contractor to provide one telephone conduit, one power conduit and power line, and foundation with anchor bolts. Conduit shall be one inch minimum size. Verify exact location with Owner. Comply with campuses standard for emergency telephones.

## **Campus Specific Information**

### **Texas A&M University**

#### **High Density Polyethylene (HDPE) Piping Installations**

High density polyethylene (HDPE) pipe is an excellent choice for sanitary collection lines, domestic water lines and chilled water lines from a sustainability standpoint. The reasons are summarized below:

- Long service life
- High resistance to corrosion, abrasion and chemicals
- Strong, durable, flexible and lightweight
- Longer pipe length with leak-proof joints
- Less energy to fabricate, transport and install than metal or concrete alternatives
- Significant overall cost savings

Texas A&M University has installed HDPE pipe to repair existing lines and for new installations on sanitary collection lines, domestic water lines and chilled water lines. Texas A&M University has chosen HDPE pipe as the standard for new construction for these three systems.

#### **Domestic Water and Chilled Water Applications**

For domestic water and chilled water applications Texas A&M University requires

minimum of SDR11 and meeting the following minimum specifications:

**Materials**

The pipe and fittings shall be made Extra High Molecular Weight (EHMW) high-density polyethylene with a standard thermoplastic material designation code of PE3608 and having a cell classification of 345464C per ASTM D3350.

Materials used to manufacture pipe and fittings shall be listed under the Manufacturer’s name in the Plastics Pipe Institute (PPI) TR-4, “PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe.” The Manufacturer shall supply a product with a standard grade HDB rating of 1600 psi (minimum) at 73°F and 800 psi (minimum) for 140°F. Upon request, the Manufacturer shall supply certification that the materials used to manufacture the pipe and fittings meet the above requirements.

All materials, which come in contact with water, including lubricants, shall be evaluated, tested and certified for conformance with ANSI/NSF Standard 61.

The materials shall meet the following nominal physical property requirements:

| PROPERTY                                     | TEST METHOD <sup>(1)</sup> | NOMINAL VALUE                   |
|--|----------------------------|---------------------------------|
| Material Designation                         | PPI/ASTM                   | PE3608                          |
| Cell Classification                          | D3350                      | 345464C                         |
| Density, Natural                             | D1505                      | 0.946 gm/cc                     |
| Density, Black                               | D1505                      | 0.955 gm/cc                     |
| Melt Index (190°C/2.16 kg)                   | D1238                      | 0.07 gm/10min                   |
| Flow Rate (190°C/21.6 kg)                    | D1238                      | 8.5 gm/10 min                   |
| Tensile Strength @ Ultimate                  | D638                       | 5,000 psi                       |
| Tensile Strength @ Yield                     | D638                       | 3,500 psi                       |
| Ultimate Elongation                          | D638                       | >800%                           |
| Flexural Modulus, 2% Secant                  | D790                       | 136,000 psi                     |
| Environmental Stress Crack Resistance (ESCR) |                            |                                 |
| F <sub>0</sub> , Condition C                 | D1693                      | >10,000 hrs.                    |
| PENT   | F1473                      | >100 hrs.                       |
| Brittleness Temperature                      | D746                       | <-180°F                         |
| Hardness, Shore                              | D D2240                    | 64                              |
| Vicat Softening Temperature                  | D1525                      | 255°F                           |
| Izod Impact Strength, Notched                | D256                       | 7 ft-lb <sub>f</sub> /in        |
| Modulus of Elasticity (short term)           | D638                       | 125,000 psi                     |
| Modulus of Elasticity (long term)            | D638                       | 30,000 psi                      |
| Thermal Expansion Coefficient                | D696                       | 1.0 x 10 <sup>-4</sup> in/in/°F |
| Average Molecular Weight                     | GPC                        | 330,000                         |
| PPI Hydrostatic Design Basis:                | D2837                      | 1,600 psi @ 73.4°F              |
| (As listed in PPI TR-4)                      |                            | 800 psi @ 140°F                 |

(1) Test procedures are ASTM unless otherwise specified. (PPI = Plastics Pipe Institute, and GPC = Gel Permeation Chromatography.)

### **Polyethylene Pipe and Fittings**

Pipe and tubing furnished under this specification shall be manufactured from compounds in compliance with Section 1.0 above. The dimensional and performance characteristics shall conform to the requirements of the most current version of AWWA C-901 (1/2" through 3") or C-906 (4" through 65"). Each lot of material shall be tested for melt index, density and % carbon. Upon request, the Manufacturer shall furnish test data.

Polyethylene fabricated fittings shall be manufactured from polyethylene pipe, sheet stock or molded fittings meeting the material requirements of this specification and all appropriate requirements of AWWA C-901 or AWWA C-906.

Pipe shall be pressure rated using the certified HDB from Section 1.2 and shall be determined in accordance with the following formula:

Where

- DR = Dimension Ratio D/t
- P = Internal pressure, psi
- S = Long term hydrostatic strength, psi (1,600)
- D = Actual outside diameter, inches
- t = Minimum wall thickness, inches
- DF = Design Factor, dimensionless (0.5 for water @ 73.4°F)

The Pressure Class (PC) of the polyethylene pipe and fittings shall be specified on the basis of the Working Pressure Rating (WPR) of the water system as defined in AWWA C-906. Recurring pressure surges (RS) are those that occur frequently and are inherent in the design and operation of the system such as normal pump startup or shutdown and normal valve opening and closing. Occasional pressure surges (OS) are those that occur infrequently and are usually the result of a malfunction such as pump seize-up, valve stem or pressure relief valve failure. The WPR shall be the lesser of the following:

- (a) WPR = PC
- (b) WPR = 1.5PC – RS
- (c) WPR = 2.0PC – OS

The pipe's DR and WPR shall be as specified by the project design engineer. The WPR as determined above must be equal to or greater than the working pressure of the system.

Polyethylene fittings, including custom fabrications, shall have the same internal pressure rating as the mating pipe. At the point of fusion, the wall thickness and outside diameter of the fitting shall be in accordance with AWWA C-901 or AWWA C-906 for the same pipe size.

The pipe Manufacturer's Quality system shall be certified to be in accordance with ISO

9001:2000.

### **Joining by Heat Fusion**

Pipe and fittings shall be joined by one of the following types of thermal fusion per the Manufacturer's recommended procedures: Butt fusion, Saddle fusion or Socket fusion.

Upon request, the Manufacturer shall provide fusion training by authorized personnel or an authorized Representative. The Contractor shall be responsible for ensuring that personnel have received proper training per the Manufacturer's recommended procedure. Records of training shall be maintained by the Contractor and should not exceed 12 months from date of construction.

Butt fusions performed between pipe ends or pipe ends and fitting outlets shall be within the following allowable wall mismatches:

- 2 DR difference for pipe and fitting diameters 6"IPS and smaller.
- 1 DR difference for above 6" through 18".
- No difference for diameters above 18".

The difference in DR's is determined from the following DR values: 7.3, 9, 11, 13.5, 17, 21, 26 and 32.5

### **Other Methods of Joining**

Polyethylene pipe and fittings may be joined together or to other materials through the use of electrofusion fittings, flange adapters with back-up rings, mechanical couplings designed for connecting polyethylene pipe and fittings to itself or to another material, or MJ adapters. The Manufacturer of the joining device shall be consulted for proper installation procedures.

### **Marking**

Pipe and tubing shall be permanently marked in accordance with all applicable standards per this specification. Marking shall be heat stamped indent print and shall remain legible under normal handling and installation practices.

Fittings shall be marked on the body or hub. Marking shall be in accordance with the applicable standard depending upon the fitting type. Mechanical fittings shall be marked with size, body material designation code, pressure rating and the Manufacturer's name or trademark.

### **Workmanship**

Pipe, tubing and fittings shall be homogenous throughout, and free of visible cracks, holes, foreign inclusions, blisters, dents or other injurious defects. The pipe, tubing and

fittings shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

### **Testing**

The Contractor shall be responsible for field set-up and performance of the fusion equipment and the fusion procedure used by the operator. Upon request, the Contractor shall verify the fusion quality by making and testing per the Manufacturer's recommended qualification procedure. The Contractor shall be responsible for the necessary adjustments to the set-up, equipment, operation and fusion procedure. Fusions that fail the qualification procedure shall be remade.

Hydrostatic testing shall be conducted in accordance with the Manufacturer's recommended testing procedures.

Low pressure pneumatic testing may be conducted on gravity sewer lines in accordance with ASTM F1417. Other methods of pneumatic testing are not recommended.

### **Third Party Certification**

The performance requirements of the pipe and fittings shall comply with the most current version of AWWA C-901 or AWWA C-906. The Manufacturer shall be listed with NSF61 certification and include the third party certification within the print line of the product.

### **Installation**

Installation of HDPE SDR11 Pipe shall be in accordance with AWWA M55 (Chapter 8).

Notes:

(1) Minimum compaction shall be to 85% Standard Proctor Density unless under a roadway where a minimum compaction shall be to 95% Standard Proctor Density.

(2) Due to the potential for ring buckling of empty pipe during roadway construction installation must have a minimum cover of 1.5 feet for pipe sizes up to 18-inches and 2 feet of cover from pipe sizes 18 to 24-inches.

(3) For chilled water applications fill material around pipe shall be a material such as DriTherm, Gilsulate or equivalent type material that will provide both insulating characteristics, support the pipe segment and be compactable to the desired conditions.

### **Sanitary Collection Applications**

For sanitary collection applications Texas A&M University believes that HDPE has advantages in given situations that make it more suitable product than traditional materials. Situations such as mall areas, heavy traffic areas, areas covered by decorative

pavers, masonry or concrete or under roadways are examples of such applications. Texas A&M recommends a minimum of SDR17 and meeting the following minimum specifications for these applications:

**Materials**

The pipe and fittings shall be made using Extra High Molecular Weight (EHMW) high-density polyethylene with a standard thermoplastic material designation code of PE3608 and having a cell classification of 345464C, D or E per ASTM D3350.

The Manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi at 73.4°F. The stress regression testing shall have been performed in accordance with ASTM D2837. Upon request, the Manufacturer shall supply certification that the materials used to manufacture the pipe and fittings meet the above requirements.

The materials shall meet the following nominal physical property requirements:

| PROPERTY                                     | TEST METHOD <sup>(1)</sup> | NOMINAL VALUE                   |
|--|----------------------------|---------------------------------|
| Material Designation                         | PPI/ASTM                   | PE3608                          |
| Cell Classification                          | D3350                      | 345464C                         |
| Density, Natural                             | D1505                      | 0.946 gm/cc                     |
| Density, Black                               | D1505                      | 0.955 gm/cc                     |
| Melt Index (190°C/2.16 kg)                   | D1238                      | 0.07 gm/10min                   |
| Flow Rate (190°C/21.6 kg)                    | D1238                      | 8.5 gm/10 min                   |
| Tensile Strength @ Ultimate                  | D638                       | 5,000 psi                       |
| Tensile Strength @ Yield                     | D638                       | 3,500 psi                       |
| Ultimate Elongation                          | D638                       | >800%                           |
| Flexural Modulus, 2% Secant                  | D790                       | 136,000 psi                     |
| Environmental Stress Crack Resistance (ESCR) |                            |                                 |
| F <sub>0</sub> , Condition C                 | D1693                      | >10,000 hrs.                    |
| PENT   | F1473                      | >100 hrs.                       |
| Brittleness Temperature                      | D746                       | <-180°F                         |
| Hardness, Shore D                            | D2240                      | 64                              |
| Vicat Softening Temperature                  | D1525                      | 255°F                           |
| Izod Impact Strength, Notched                | D256                       | 7 ft-lbf /in                    |
| Modulus of Elasticity (short term)           | D638                       | 125,000 psi                     |
| Modulus of Elasticity (long term)            | D638                       | 30,000 psi                      |
| Thermal Expansion Coefficient                | D696                       | 1.0 x 10 <sup>-4</sup> in/in/°F |
| Average Molecular Weight                     | GPC                        | 330,000                         |
| PPI Hydrostatic Design Basis:                | D2837                      | 1,600 psi @ 73.4°F              |
| (As listed in PPI TR-4)                      |                            | 800 psi @ 140°F                 |

(1) Test procedures are ASTM unless otherwise specified. (PPI = Plastics Pipe Institute, and GPC = Gel Permeation Chromatography.)

**Polyethylene Pipe and Fittings**



Pipe and tubing furnished under this specification shall be manufactured from compounds in compliance with Section 1.0 above. The dimensional and performance characteristics shall conform to the requirements of ASTM F714 for sizes 4"IPS and larger and to ASTM D3035 for sizes smaller than 4"IPS. Each lot of material shall be tested for melt index, density and % carbon. Upon request, the Manufacturer shall furnish test data.

Polyethylene fabricated fittings shall be manufactured from polyethylene pipe, sheet stock or molded fittings meeting the material requirements of this specification.

Pipe shall be pressure rated using the HDB from Section 1.2 and shall be determined in accordance with the following formula:

Where

- DR = Dimension Ratio D/t
- P = Internal pressure, psi
- S = Long term hydrostatic strength, psi (1,600)
- D = Actual outside diameter, inches
- t = Minimum wall thickness, inches
- DF = Design Factor, dimensionless (0.5 for water @ 73.4°F)

Polyethylene fittings, including custom fabrications, shall have the same internal pressure rating as the mating pipe. At the point of fusion, the wall thickness and outside diameter of the fitting shall be in accordance with ASTM F714 or D3035 for the same pipe size.

The pipe Manufacturer's Quality system shall be certified to be in accordance with ISO 9001:2000.

### **Joining by Heat Fusion**

Pipe and fittings shall be joined by one of the following types of thermal fusion per the Manufacturer's recommended procedures: Butt fusion, Saddle fusion or Socket fusion.

Upon request, the Manufacturer shall provide fusion training by authorized personnel or an authorized Representative. The Contractor shall be responsible for ensuring that personnel have received proper training per the Manufacturer's recommended procedure.

Butt fusions performed between pipe ends or pipe ends and fitting outlets shall be within the following allowable wall mismatches:

- 2 DR difference for pipe and fitting diameters 6" IPS and smaller.
- 1 DR difference for above 6" through 18".
- No difference for diameters above 18".

The difference in DR's is determined from the following DR values: 7.3, 9, 11,13.5, 17, 21, 26 and 32.5.

### **Other Methods of Joining**

Polyethylene pipe and fittings may be joined together or to other materials through the use of electrofusion fittings, flange adapters with back-up rings, mechanical couplings designed for connecting polyethylene pipe and fittings to itself or to another material, or MJ adapters. The Manufacturer of the joining device shall be consulted for proper installation procedures.

### **Marking**

Pipe and tubing shall be permanently marked in accordance with all applicable standards per this specification. Marking shall be heat stamped indent print and shall remain legible under normal handling and installation practices.

Fittings shall be marked on the body or hub. Marking shall be in accordance with the applicable standard depending upon the fitting type. Mechanical fittings shall be marked with size, body material designation code, pressure rating and the Manufacturer's name or trademark.

### **Workmanship**

Pipe, tubing and fittings shall be homogenous throughout, and free of visible cracks, holes, foreign inclusions, blisters, dents or other injurious defects. The pipe, tubing and fittings shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

### **Testing**

The Contractor shall be responsible for field set-up and performance of the fusion equipment and the fusion procedure used by the operator. Upon request, the Contractor shall verify the fusion quality by making and testing per the Manufacturer's recommended qualification procedure. The Contractor shall be responsible for the necessary adjustments to the set-up, equipment, operation and fusion procedure. Fusions that fail the qualification procedure shall be remade.

Hydrostatic testing shall be conducted in accordance with the Manufacturer's recommended testing procedures.

Low pressure pneumatic testing may be conducted on gravity sewer lines in accordance with ASTM F1417. Other methods of pneumatic testing are not recommended.

### **Third Party Certification**

This section shall apply when the application references high-density polyethylene, EHMW, PE3608 suitable for potable water. The product shall be manufactured per AWWA C901 (1/2" through 3") or AWWA C-906 (4" through 63"). The Manufacturer shall be listed with NSF-61 certification and include the third party certification within the printline of the product.

### **Installation**

Installation of HDPE SDR11 Pipe shall be in accordance with AWWA M55 (Chapter 8).

Notes:

- (1) Minimum compaction shall be to 85% Standard Proctor Density unless under a roadway where a minimum compaction shall be to 95% Standard Proctor Density.
- (2) Due to the potential for ring buckling of empty pipe during roadway construction installation must have a minimum cover of 4 feet for pipe sizes up to 24-inches.

### **Underground Piping Installation and Insulation Requirements**

Uninsulated underground thermal piping systems experience significant energy losses to the soil over the course of their operating life. For example, a 100 foot section of uninsulated 12 inch HDPE Chilled Water line buried 3 feet below grade can easily gain over one billion Btu's of heat over a 30 year period. To minimize the heat gain/loss of these piping systems, Texas A&M University has chosen a mineral powder insulation system, similar to Gilsulate 500, as the Campus standard for insulating underground thermal lines. In addition to its insulating properties, this type of insulation system: 1) Is hydrophobic, 2) Has a high electrical resistivity preventing galvanic action between metal pipe and the soil, 3) Has good load bearing properties and 4) Is "green" since it's made from minerals.

### **Work Includes:**

An underground piping insulation system must be provided to enclose and provide thermal and waterproofing protection for piping specified and shown on Plans, including but not limited to the following:

- Piping insulation including expansion units.
- Miscellaneous materials incidental to complete installation of insulated underground sections.
- Supervision of installation as specified.

### **General:**

Insulating material which adheres to or becomes joined in any manner to piping during

cycle of operation shall not be used.

Contractors are solely responsible to complete work for entire run of piping between points specified and shown on plans.

Adequate space and clearance with insulated underground piping system shall be provided to allow free movement of piping and avoid stress or abrasions to piping. No wood, masonry, metal, or any other abrasive pipe supports or guides, shall be left in contact with piping.

Provide fittings and accessories necessary and incidental to type of system selected.

Store materials and equipment on work site on wood platforms or members; stack and pile in substantial and safe manner so products will not easily dislodge while in storage.

Replace or repair wet or damaged insulation as directed by Engineer or product installation requirements.

Complete hydrostatic tests for all new lines. Perform hydrostatic leak test at 1.5 times maximum operating pressure to ensure piping system is free from leaks before application of field applied insulation and closures. UEM technical staff must be notified in advance of planned hydrostatic test and be present to witness the test. See pipe manufacturer's recommendations for testing procedures.

All parts of system to be intact, undamaged, and free from leaks before backfilling with insulation material. Upon completion of backfilling of insulation material, work must be approved by construction inspector and UEM representative before final backfilling is performed. Piping or insulation installation that is deemed to be inadequate or incorrect by Engineer, construction inspector, or UEM representative must be corrected to meet specifications prior to backfilling.

### **Excavation, Filling & Backfilling**

Final grading for setting pipe units to be performed immediately prior to setting units or concrete supporting pad in trenches; backfilling around completed insulated system to be under direction of supervisor for installation of insulated underground system.

Restore all finished grades and improvements as detailed.

### **Type of Construction:**

The system for insulating pipes shall keep water and moisture from pipes.

Type of material and construction: The insulation shall be a dry, free flowing granular product formulated from selected inert, inorganic materials. It shall be non-toxic, non-

flammable, and completely free of asbestos. It shall require no mixing prior to installation, and no curing. It shall be completely compatible with all materials typically used for piping in the service temperature range of +35°F to +230°F. It shall be of sufficient density so any stones or rocks inadvertently falling on insulation will not penetrate or migrate into or through insulation during placement and back-filling operations.

The insulation shall be composed of granular particles that cohesively bond with each other to form a closed cell compacted mass that effectively isolates pipe surfaces from air, water, moisture and chemicals. The granules shall be surface treated to render it hydrophobic. Insulation manufacturer must provide documentation of completion of Corps of Engineers 10 ft. head of water test (14 days - less than 1% moisture gain). The compacted insulation shall be capable of withstanding up to 12,000 psf (58,000 kg/M<sup>2</sup>) at the manufacturer's recommended density.

The insulation shall have a thermal coefficient of heat conductivity (K factor) of no more than 0.60 BTU/hr. /ft<sup>2</sup>/°F/in. at manufacturer's recommended use density and a mean temperature of 175°F and 0.65 at a mean temperature of 300°F by the guarded hot plate method of ASTM C-277. If insulation with higher thermal conductivity is proposed, bidding shall be based on the equivalent amount of insulation required to minimize heat loss/gain to that which would result with the thermal conductivities specified in the preceding sentence. See Figure No. 1 for required insulation envelope dimensions.

Electrical resistivity of the insulation shall be greater than 10<sup>12</sup> Ohm-cm.

The insulation shall be mineral powder with characteristics as described above similar to GILSULATE 500 as manufactured by American Thermal Products Inc.

The system shall be installed according to the published recommendations of the insulation manufacturer. The installer shall consult with and arrange for field assistance from the manufacturer's representative prior to placement of the insulation system. Pipes, anchors-guides and expansion shall be in compliance with the recommendations of the insulation manufacturer or as shown on plans and specifications. Backfilling operations shall be performed according to Section, EXCAVATION, FILLING AND BACKFILLING.

Placing Materials: Insulation materials used must be capable of being placed and consolidated to prescribed density prior to any backfilling operation. Use of backfill to provide compaction of the material is not acceptable.

Installation Sequence: (Refer to Insulation Manufacturer's Installation Sequence and notes.)

Excavate trench as near as possible to the required width of piping and insulation and

pile backfill all on one side. Install pipes with required guides, supports, and anchors as shown on drawings and specifications. Perform pressure testing.

Grade and compact trench under pipes leaving required space for specified thickness of insulation. Clean any dirt or debris off pipes.

Precut gypsum board with attached spacers on the exterior may be driven into place. Horizontal spacers are used to determine envelope width. Leave forming in place. Forms are held away from pipes by temporary spacers which must be removed as insulation is installed and consolidated. Side forms must not extend above the finished consolidated insulation level of the envelope.

Provide compact sand or clean backfill behind the forms to pipe height.

All standing water shall be removed prior to placing insulation.

To minimize dust, empty the bags near pipes with as little “free fall” as possible. Fill trench to mid pipe height and consolidate. Remove spacers and temporary supports as work progresses.

Add additional layers of insulation and consolidate to specified thickness and density. A rod type concrete vibrator with a 1½ - 2” diameter head is the best and quickest means of consolidating insulation. Insert the head of the vibrator and pull along slowly.

Walk on the consolidated insulation envelope to insure use density, footprints of approximately 1” deep or less are expected. Insulation coverage shall be according to insulation manufacturer recommendations or as shown on Plans.

Additional 2” of insulation is required over pipes in areas passing under streets or parking.

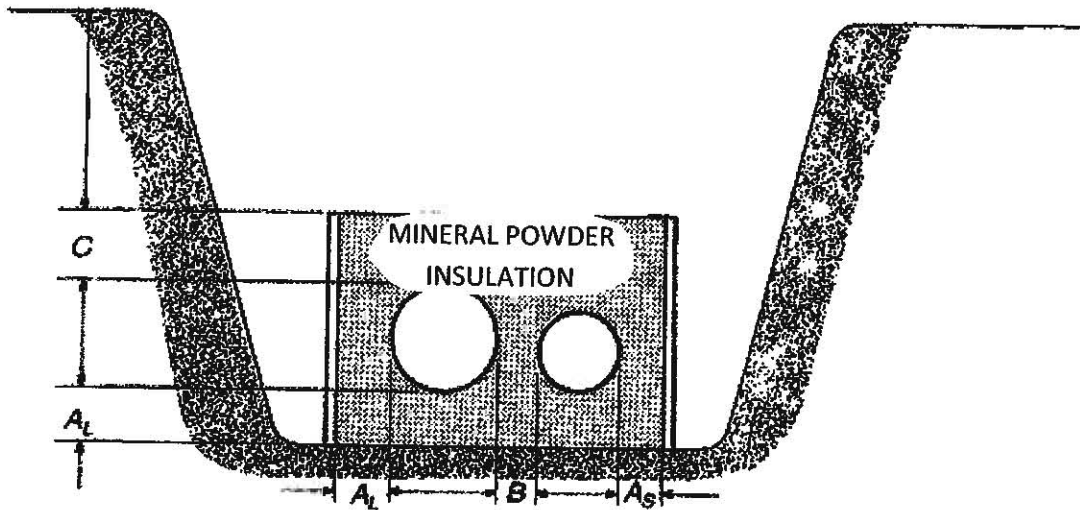
Complete compaction of sand backfill behind forms. Place a layer of flattened empty bags on top of the insulation envelope. Walk on top of the bags and hand place 6” clean backfill on top of empty bags to protect against damage in case of storms. Complete backfilling to grade level as specified under Section, EXCAVATION, FILLING, & BACKFILLING as soon as possible. Provide a minimum of 12” earth backfill.

Guarantee: Contractor shall guarantee installation of insulating system for a period of one (1) year from date of acceptance by Owner against deterioration of insulating value, compaction or water leakage under normal operation conditions. Contractor, however, shall not be responsible for damage or failure of system due to damage caused by other parties.

# Design of the Insulation Envelope

## Pipe Coverage Selection

Figure No.1



A<sub>1</sub>. COVERAGE FOR LARGE PIPE DIAMETER  
 A<sub>2</sub>. COVERAGE FOR SMALL PIPE DIAMETER  
 B. SELECTED FOR SMALL PIPE DIAMETER  
 C. COVERAGE FOR LARGE PIPE DIAMETER

TABLE 1

| Gilsulate 500 or Approved Equal Envelope Dimensions |              |                  |                      |   |   |                |   |   |
|---|--------------|------------------|----------------------|---|---|----------------|---|---|
| Operating Temperature                               |              |                  | 35°F To 100°F        |   |   | 101°F To 230°F |   |   |
| Norm. Pipe Size                                     | Outside Dis. | Pipe Area Sq.In. | Dimensions In Inches |   |   |                |   |   |
|   |              |                  | A                    | B | C | A              | B | C |
| 1   | 1.315        | 1.36             | 3                    | 6 | 4 | 3              | 6 | 4 |
| 2   | 2.375        | 4.43             | 3                    | 6 | 4 | 3              | 6 | 4 |
| 3   | 3.500        | 9.62             | 3                    | 6 | 5 | 3              | 6 | 5 |
| 4   | 4.500        | 15.90            | 4                    | 6 | 5 | 4              | 6 | 5 |
| 5   | 5.563        | 24.31            | 4                    | 6 | 5 | 4              | 6 | 5 |
| 6   | 6.625        | 34.47            | 4                    | 6 | 5 | 4              | 6 | 5 |
| 8   | 8.625        | 58.43            | 4                    | 6 | 5 | 5              | 6 | 6 |
| 10  | 10.750       | 90.76            | 4                    | 6 | 6 | 5              | 6 | 6 |
| 12  | 12.750       | 127.68           | 4                    | 6 | 6 | 6              | 6 | 7 |
| 14  | 14.000       | 153.94           | 5                    | 6 | 6 | 6              | 6 | 7 |
| 16  | 16.000       | 201.06           | 5                    | 6 | 6 | 6              | 6 | 7 |
| 18  | 18.000       | 254.47           | 5                    | 6 | 6 | 6              | 6 | 8 |
| 20  | 20.000       | 314.16           | 5                    | 6 | 7 | 6              | 6 | 8 |
| 24  | 24.000       | 452.39           | 5                    | 6 | 7 | 6              | 6 | 8 |

Based on thermal conductivities ( K factors) of Gilsulate 500xr insulation.

If a product with higher K factors is proposed, insulation thicknesses shall be increased to provide a resistance to heat flow equivalent to the Gilsulate insulation shown in Figure 1.

Add 2 inches to C Dimension under streets. Parking lots and railroads tracks.

## Manhole Covers

Texas A&M University in College Station has standardized utility manhole covers to be used for all underground utility access on campus. All new utility manhole cover installations must use a fiber reinforced polymer cover manufactured by McGard Special Products (see attached specification sheet). These reinforced polymer manhole covers can be ordered in a variety of sizes, will all have built-in locking devices with an internal release and have a number of other benefits over conventional cast iron or steel covers.

- Polymer covers are approximately  $\frac{1}{4}$  the weight of an equivalent size cast cover
- Standard thickness is used for pedestrian and non-vehicular application
- Available in DOT-rated thickness to be used for vehicular traffic on roadways and drives
- Top surface is slip resistant
- Does not retain heat as readily as conventional cast covers
- Available with venting if needed for specific application
- Locking device will be used with a unique key for Texas A&M University in College Station
- Locking device must be ordered with internal release mechanism to allow for personnel egress
- Available in standard sizes and also in a variety of round, square, and rectangular sizes
- Custom sizes with custom locking mechanism available depending upon specific requirement
- “UTILITIES” to be cast into center of all manholes together with utility commodity name (ELECTRICAL, THERMALS, SANITARY, STORM) where applicable – see attached drawing
- No commodity name to be shown on access covers for utility tunnels
- All covers to be ordered with locking device and internal release
- Use McGard Registration Code No. 9500540 to order cover locking device unique to TAMU
- TAMU Utilities & Energy Management will maintain and control inventory of unique cover keys

### **Fibershield Manhole Lock Specification (Patent Pending)**

#### **Required Function**

The FiberShield is a lightweight manhole cover with H-20 & AASHTO HS-25 load rating. The FiberShield weighs approximately 1/4 of an equivalent size cast iron cover. A special operating key is required to unlock/remove the FiberShield from the frame.

#### **Overall Design Criteria**

The FiberShield is designed as a direct replacement for existing cast iron covers. The cover is rated to handle arterial traffic flow. The cover has a self contained locking



system. The locking system provides cover to frame retention and security from unauthorized entry.

### **Specific Design Criteria Base Cover**

The FiberShield Manhole cover is manufactured from Fiber Reinforced Polymer. -The FiberShield is available in multiple colors and custom logos. -The FiberShield is manufactured with an “anti-slip” top surface. The FiberShield utilizes an optional rubber gasket around the perimeter to provide dampening and reduce wear. -The FiberShield is available in two load ratings – 80,000 lb & 50,000 lb. The FiberShield has maximum deflection of .75 inches @ AASHTO H-20 wheel loading of 16,000 lb.

The FiberShield has been successfully subjected to accelerated fatigue testing @ 29,000 lb & 20,000 cycles. Full details available upon request.

The Fiber Shield has been successfully static and dynamic load tested at both 160°F and 60°F.

The FiberShield is available in most common sizes from 24” to 32”. Custom sizes available upon request.

The FiberShield has a self-contained locking system mounted on the underside. The locking system prevents the FiberShield from lifting out of the frame.

### **Locking System**

The locking system is manufactured from a combination of molded plastic and fabricated stainless steel components.

The locking system consists of security drive bolt, two spring loaded pistons, skid runners, latch plate mechanism, piston actuation cable and two plastic protective caps.

The security drive bolt uses a proprietary key drive system.

The security drive bolt is protected with a molded nylon protective cap.

The security drive bolt is manufactured from heat treated stainless steel to maximize strength, durability, and resist strong arm tools. The drive bolt actuates the latch mechanism.

The latch mechanism is manufactured from heat treated stainless steel for maximum strength and durability. The latch mechanism actuates both spring loaded pistons. The master side is connected directly to the latch mechanism. The slave side is driven via a nylon coated stainless steel braided cable.

The spring loaded pistons are manufactured from 304 stainless steel tubing. The springs

are manufactured from 302 stainless steel.

The skid runners are manufactured from PVC tube. The skid runners are attached to the underside of the cover via molded nylon feet.

The skid runners allow the FiberShield to be removed from the manhole frame and dragged along the pavement without damaging the lock mechanism.

The locking system components can be easily replaced with common tools in the event it they become damaged or worn.

The locking system has drain slots located near the security drive bolt to allow water and debris to pass thru.

### **Operating Key**

The multi-purpose (MP) T-Key is used to unlock and lock the cover.

The MP T-Key is manufactured from alloy steel components which are covered with powder coat paint or zinc plating for corrosion protection.

The MP T-Key has a screwdriver storage location in the handle. The screwdriver is used for removing the plastic protective cap and cleaning debris from the security bolt counterbore.

The MP T-Key has a security key mounted on the lower end of the long shaft. The security key is manufactured from heat treated alloy steel and zinc plated for corrosion protection.

The MP T-Key has a swivel joint on the top of the long shaft. The swivel joint has two features – a threaded stud and a straight stud. The threaded stud is used to remove the FiberShield from the frame. The straight stud is used to disengage the latch mechanism (lock the FiberShield).

The MP T-Key has an extra key storage post located on the handle. The extra key storage post is used to store an extra key on the handle.

### **FiberShield Operation**

The FiberShield is operated with the following sequence of operations (starting with the FiberShield in the frame in the locked position).

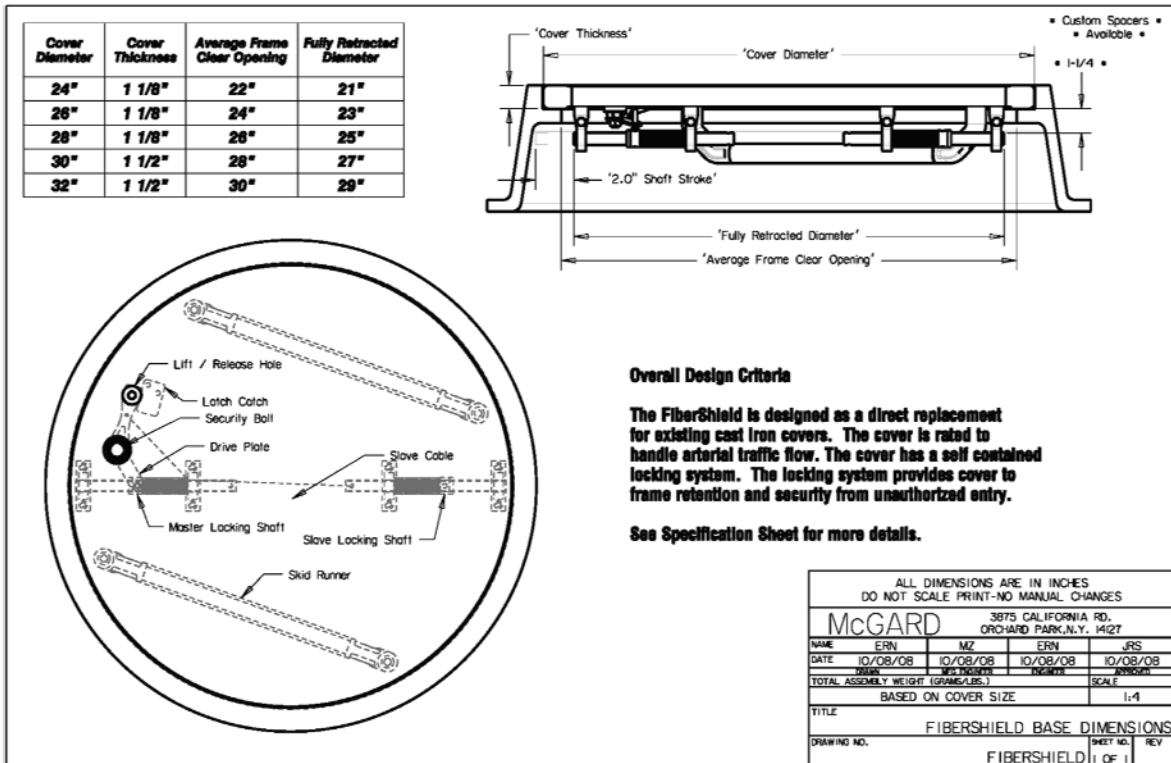
### **FiberShield Removal**

Remove the small screwdriver in the T-Key handle to pierce and remove the protective cap from the security drive bolt and cover lift hole. -Insert T-Key drive pattern into

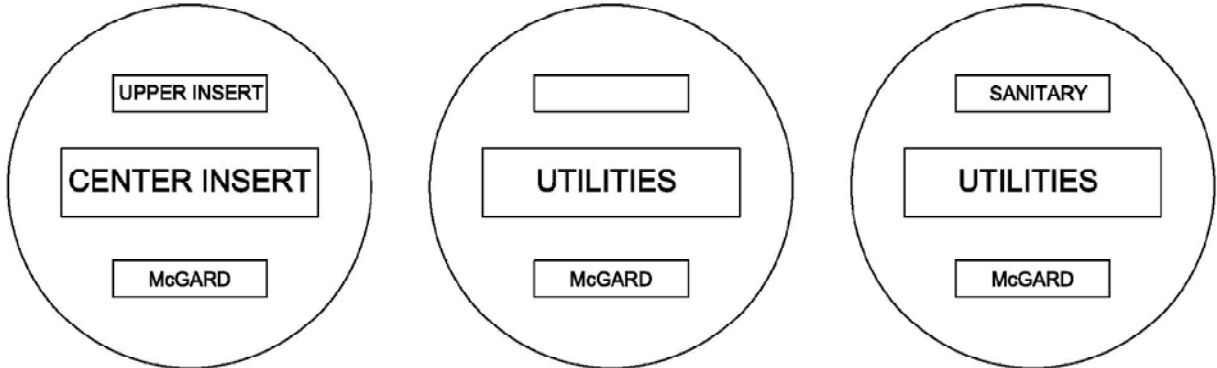
security drive bolt. -¼ turn CCW until “audible click”. The pistons are retracted and held in the retracted position via a latch mechanism. -Flip T-Key over and screw cover removal stud into the FiberShield lift hole (where it mates with a female thread). -Lift and remove cover. Drag cover to a safe location. -Leave T-Key attached to the cover. The T-Key acts as safety device insuring the pistons aren’t accidentally activated.

**FiberShield Replacement**

Drag FiberShield to the open frame and insert. -Unscrew the T-Key from the FiberShield lift hole. -Rotate and exchange the cover removal stud for the cover locking stud. -Insert the cover locking stud into the FiberShield lift hole. -Using your foot push the T-Key handle to disengage the latching mechanism. -Replace the plastic protective cap on the security bolt and lift hole.

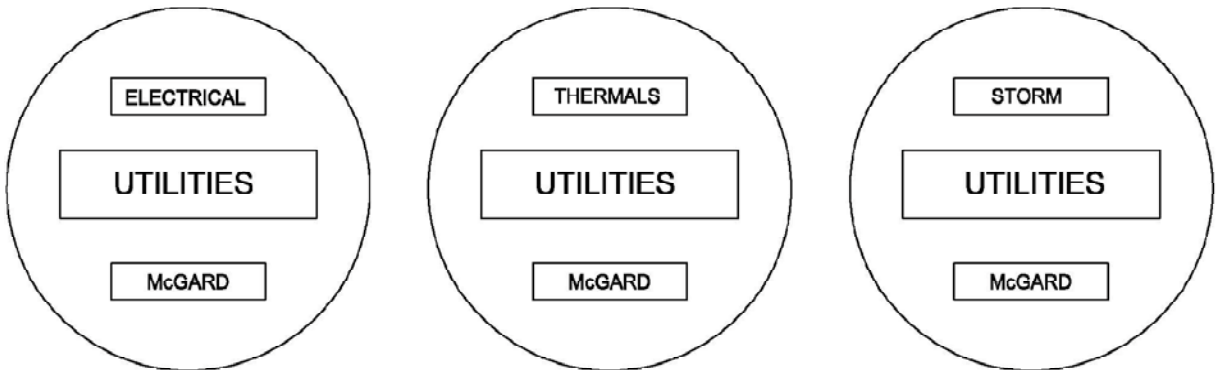


## MANHOLE COVER MARKING STANDARDS



EXAMPLE TUNNELS

COVER LOGO INFORMATION  
CENTER INSERT (18"x6")  
UPPER INSERT (10"x2")



### Medium Voltage Electrical Equipment

All underground distribution medium voltage electrical switchgear shall be manufactured by Trayer Engineering Corporation. Typically, a new construction project will require a 4 or 5-way 15kV Vacuum Load Interrupter or Vacuum Fault Interrupters with visible disconnects.

Only the use of new copper wound, loop fed transformers are permitted for use in the 12.5kV TAMU electrical distribution (aluminum wound transformers are not acceptable for use).

Only use drain wire type cable with the following specifications:

description conductor: annealed bare copper  
compact class b extruded strand shield  
extruded black conducting stress control  
layer over conductor. insulation ethelene  
propylene rubber (epr) insulation colored to composite with  
black conducting shield layers. Composite insulation shield  
and jacket six corrugated copper drain wires embedded  
in an extruded black conducting black chlorinated  
polyethylene (cpe-130) composite insulation shield and  
jacket trade name: unishield 15kv 133% .220mil mv105

## Manholes

### Manhole Cabling

- All cables are to be wrapped one time around manhole.
- Every wall shall have two support racks mounted in order to support cable.
- Insulators shall be put on every support arm and zip tied down.
- Fire taping shall be used from duct to the termination.

### Grounding

- All manholes shall have a minimum of two 5/8" by 10' grounding rods.
- All racks are to be grounded into a contact point.
- All switches and electrical equipment mounted in manholes shall be grounded.
- The ladder and racks shall be grounded.

### Sump Pump

- All manholes with switches will have sump pumps installed in them.
- An extra 2" PVC pipe shall be used for sump pump circuit.
- All manholes shall have a sump pit that is a minimum of 1 foot deep, and 18" x 18" in width and length.

### General Installation Procedures:

- Manholes shall have a minimum of a 42" hole opening.
- Ladder ups will be mounted in the center of every ladder.
- All 600 amp T-bodies and 200 amp elbows will have test points.
- All manholes will be clean at the completion of the project.
- Stabilizing sand shall be used for installation of all manholes.
- A minimum of 10 feet of rigid conduit with galvanized bell ends shall be required on each duct bank coming in and going out of the manhole.

- All conduits shall be cut off flush with the wall in the manholes
- All electrical manhole covers shall be labeled with 'ELECTRIC' on the top of them.
- All cables shall be labeled with feeder number and bldg numbers, cables should be marked with red and blue marking tape to identify the phases
- All switches shall be anchor down and set so that it can be operated from manhole lid opening
- Any position on the switch that is not used shall have a bushing well insert on the switch and a dust cover on the bushing and shall be grounded.
- Any terminations in the manhole shall be supported between the rack in the manhole and as close the wall as possible.
- All empty ducts coming into manholes shall be sealed off
- All fire taping shall be wrapped with cloth taping (3M 27cloth tape)
- All ducts shall be swapped before sealing or pulling cable and shall have a pull string in each conduit
- All racks shall be as high as possible in manhole
- Manhole lids shall be 4" above final grade

Precast concrete TAMU electrical manholes 8` X 10` X 8' including thin-wall knockout, pull irons, sump box with grate, ground rod sleeve, "Safrail" fiberglass

Precast concrete TAMU electrical manholes 8` X 10` X 8' including thin-wall knockout, pull irons, sump box with grate, ground rod sleeve, "Safrail" fiberglass ladder, "Bilco" ladder up. 1 neck extension and a McKinely #SS38l ring & a ductile iron cover marked "ELECTRIC" cast bin to a 42" diameter precast concrete neck extension X21" high.

## **Telecommunications Manhole**

Manholes for telecommunication ductbank shall be 36 inch by 60 inch by 36 inch deep split bottom fiberglass vault as manufacture by Armorcast (Part No. 6001436AS-GTE) with the following:

20k polymer concrete covers with non-skid surface and hinged metal frame

Hex head lockdown system

Four 4 inch terminators, 2 at each end aligned for straight pull through

Two 1 inch pulling eyes, 1 at each end

Six 14 hole cable racks with grounding ribbon

Two slotted drains and one 8 inch sump in polymer concrete base

## **Exterior Site Lighting**

The equipment specified for campus site lighting has been selected to provide the basis for the design of functional, safe, cost effective, low glare, aesthetically pleasing illumination of pedestrian, parking and roadway areas.

Luminaires specified have high performance optical systems to direct a high % of lamp lumens into desired areas to minimize luminaire/pole requirements.

Luminaires specified are designed to shield the light source from the eye to reduce glare and improve visual comfort and visibility.

Luminaires specified are sealed with silicone at every point of entry against the penetration of moisture, dirt and insects.

Luminaires are specified to respect and enhance established TAMU campus aesthetics.

The new campus standard for lamps replaces a yellow light source (high pressure sodium) with a white light source (metal halide).

White light is preferred at night over yellow light. It improves visibility and color rendering of objects and people.

The high performance, advanced metal halide system specified is the most efficient metal halide system available with an efficacy up to 120 initial lumens/watt compared to 75 initial lumens/watt for a comparable standard metal halide lamp.

The high performance, advanced metal halide system has a high lumen maintenance and a low lamp failure rate.

Standardization for luminaires, poles and lamps results in reduced and standardized inventory and consistency on all projects with regard to the attributes cited above.

### **Pedestrian & General Area Lighting**

Luminaire: Gardco Model CP17 - \* - \*\* - \*\*\* -200-277-BRA311-PC

- Notes:
1. \* denotes “Mounting”-Letter code to be selected by Engineer based on project requirements
  2. \*\* denotes “Distribution”-Letter code to be selected by Engineer based on project requirements.
  3. \*\*\* denotes “Wattage”-Letter code to be selected by Engineer based on project requirements.

Pole: 10’ Pole – Gardco Model TAMU-TRA-CB-10L-D1-BRA311  
15’ Pole – Gardco Model TAMU-TRA-CB-15L-D1-BRA311

- Notes:
1. “D1” in Model # designates light duty. Engineer shall specify correct pole strength based on site wind load factors.
  2. Approved equal from Sterner is acceptable.

Lamp: High Performance Advanced Metal Halide

60 Watt to 140 Watt – Philips CosmoPolis CosmoWhite System

**Historical Pedestrian & Heritage Area Lighting** (standard in designated historical areas)

**Luminaire:** Lumec Model Z47A-\* -5-AC-\*\*-SFZ4-SC1-LMS18161A

Notes: 1.\* denotes “Lamp”-Letter code to be selected by Engineer based on project requirements.  
2. \*\* denotes “Voltage”-Letter code to be selected by Engineer based on project requirements.

**Pole:** Lumec Model R50-12-FS2-SCq-LM18161A

**Lamp:** High Performance Advanced Metal Halide  
60 Watt to 140 Watt – Philips CosmoPolis CosmoWhite System

**Parking & Roadway Lighting**

**Luminaire:** Gardco Model EH19-\* -\*\*-\*\*\*-\*\*\*\*-BRA311-PC

Notes: 1. EH19 becomes H26 for Wattages from 750 to 1,000 Watts.  
2. \* denotes “Mounting”-Letter code to be selected by Engineer based on project requirements  
3. \*\* denotes “Distribution”-Letter code to be selected by Engineer based on project requirements.  
4. \*\*\* denotes “Wattage”-Letter code to be selected by Engineer based on project requirements.  
5. \*\*\*\* denotes “Voltage”-Letter code to be selected by Engineer based on project requirements.

**Pole:** 30’ Pole – Gardco Model TAMU-TRA-CB-30L-D1-BRA311

Notes: 1. “D1” in Model # designates light duty. Engineer shall specify correct pole strength based on site wind load factors.  
2. Approved equal from Sterner is acceptable.

**Lamp:** 210 Watt to 315 Watt – High Performance Advanced Metal Halide, Philips MasterColor Elite System (Color Temperature 3000 degrees Kelvin)

Above 315 Watt – Philips MasterColor Elite System if available, if not Pulse Start MH

**Bollard Lighting**

**Equipment:** Bollard with LED – Gardco Model TAMU-BRM830-42-DR-NW-360-\*



-SC/BRA311

Non Illuminated Bollard – Gardco Model TAMU-42-NONLIT-SC/BRA311

Notes: 1. \* denotes “Voltage”-Letter code to be selected by Engineer based on project requirements.

**Building Mounted Luminaires**

Luminaire: Luminaires to be selected to meet architectural and technical requirements of specific projects on a case-by-case basis

Lamp: 60 Watt to 140 Watt – Philips CosmoPolis CosmoWhite System if available  
210 Watt to 315 Watt – Philips MasterColor Elite System (Color Temperature 3000 Degrees Kelvin) if available  
If Philips High Performance Metal Halide is unavailable use Pulse Start MH

**Typical Design Lighting Level**

TAMU follows the lighting level chart below as a guide, refer to IESNA, TXDOT, and local codes requirements for new installations.

| <b>Lighting Levels</b>                       |                                |                                |                               |                               |                         |
|--|--------------------------------|--------------------------------|-------------------------------|-------------------------------|-------------------------|
| <b>Location</b>                              | <b>Min. Horiz. Footcandles</b> | <b>Avg. Horiz. Footcandles</b> | <b>Min. Vert. Footcandles</b> | <b>Avg. Vert. Footcandles</b> | <b>Uniformity Ratio</b> |
| <b>General Area</b>                          |                                |                                |                               |                               |                         |
| Non-designated Pedestrian Ways               | 0.5                            | ...                            | ...                           | ...                           | ...                     |
| Large Open Areas Requiring Surveillance Only | ...                            | ...                            | 0.05                          | 0.2                           | ...                     |
| Confined Areas Requiring Surveillance Only   | ...                            | ...                            | 0.1                           | 0.5                           | ...                     |
| <b>Pedestrian Ways</b>                       |                                |                                |                               |                               |                         |
| Type A - Roadside                            | 1.0                            | ...                            | ...                           | 2.2                           | 5:1                     |
| Type B - Distant from Roadway                | 0.5                            | ...                            | ...                           | 0.5                           | 5:1                     |

|   |     |     |     |     |     |
|---|-----|-----|-----|-----|-----|
| Areas 6.5' to 16' on Each Side of Type B ways | 0.2 | ... | ... | 0.2 | ... |
| Parking Areas Open Facilities                 | 0.9 | ... | ... | ... | 4:1 |
| Covered Facilities                            | ... | 5.0 | ... | ... | 4:1 |
| <b>Roadways</b>                               |     |     |     |     |     |
| Major   | ... | 1.2 | ... | ... | 3:1 |
| Collector                                     | ... | 0.8 | ... | ... | 4:1 |
| Local   | ... | 0.6 | ... | ... | 6:1 |

### Overhead Distribution

Poles shall be used only at the discretion of the University. Overhead distribution is generally being replaced by underground lines.

#### Materials

- All poles shall use S&C brand cutouts.
- All materials shall be hot-dipped galvanized including nuts, bolts, and others.
- Rebuilds (refurbished poles) are prohibited.  
All Poles shall be creosote pressure treated.
- All Poles, regardless of length, shall be of Class 2 (C-2) designation.

#### Grounding

- All poles shall be butt wrap grounded and ground-rod attached.

#### Plain Poles

#### Riser Poles

- Any primary riser pole shall have no other equipment mounted onto it including transformers.
- All riser poles shall have riser brackets designed for use on overhead systems (i.e. use of unistrut or standoffs is not acceptable).
- Any primary or secondary riser shall have a OZ bushing

#### Dead End Pole

- One guy-strain insulator shall be used in each respective guy.
- Conductor size shall depend on anchor size.
- Clearance shall be 20 feet wide and clear of all potential obstructions.

#### Overhead Poles with Transformers:

- Transformer mounted poles shall not have a device arm installed.

- Single transformer installations may be bolt-mounted. However, any transformer bank cluster consisting of two or more transformers shall utilize an aluminum-form transformer bank rack.
- No transformers larger than 75kva shall be mounted on the poles.

## Tarleton State University

### Site Lighting

#### **Pedestrian & General Area Lighting**

Luminaire: Kim Lighting Type 5 Post Top Mounted Shoebox 5SQ-168 Dark Bronze

Lamp: High Pressure Sodium

Pole: Kim Lighting PSA14-4125-FM-DB-P

Color: Dark Bronze

#### **Antique Street Lamp and Pole**

Luminaire: King Luminaire K118 Washington

Lamp: High Pressure Sodium

Pole: King Luminaire KF77-10 Ductile Iron

Color: Dark Antique Green

#### **Parking & Roadway Lighting**

Luminaire: Kim Lighting Type 5 Post Top Mounted Shoebox 5SQ-168 Dark Bronze

Lamp: High Pressure Sodium

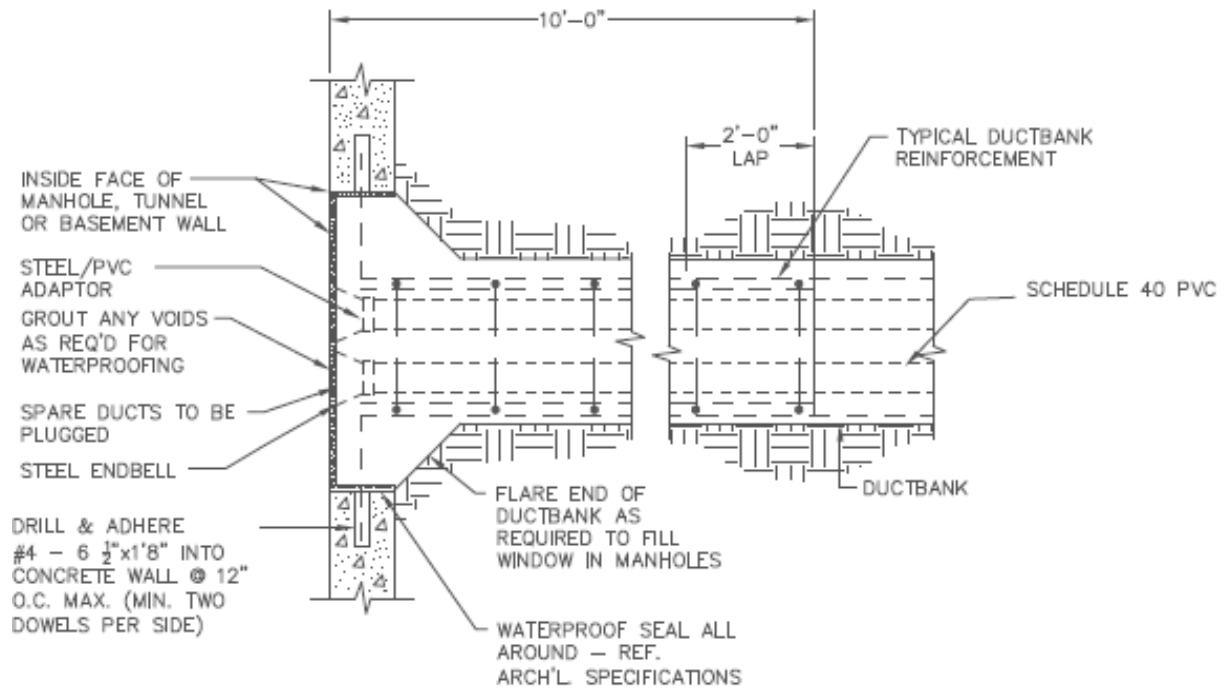
Pole: 24 foot and Valmont DS210 Round Tapered 39 foot

Color: Dark Bronze

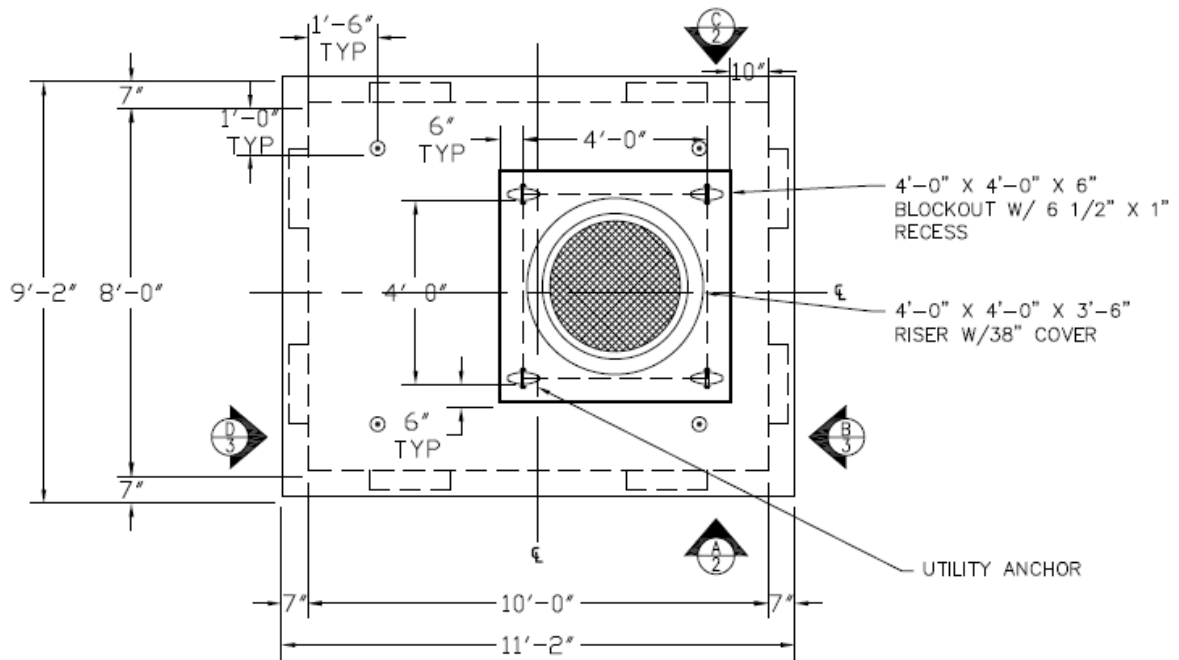
## Prairie View A&M University

### Site Lighting

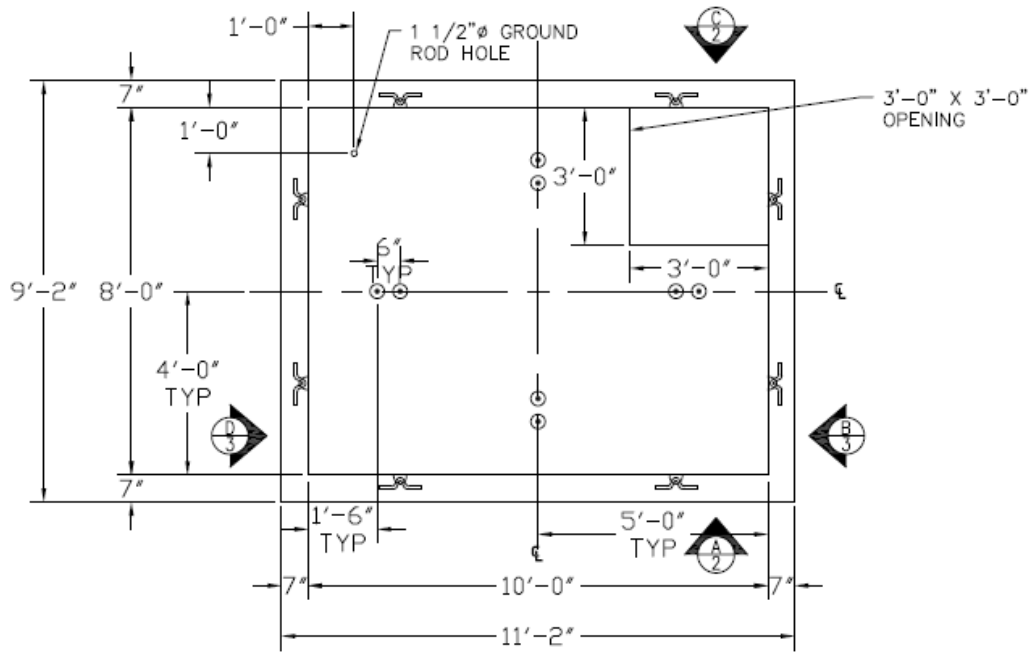
All exterior light fixtures shall be 277 volt and receive their power from an emergency generator.



Electrical Ductbank Entrance Detail  
Not to Scale

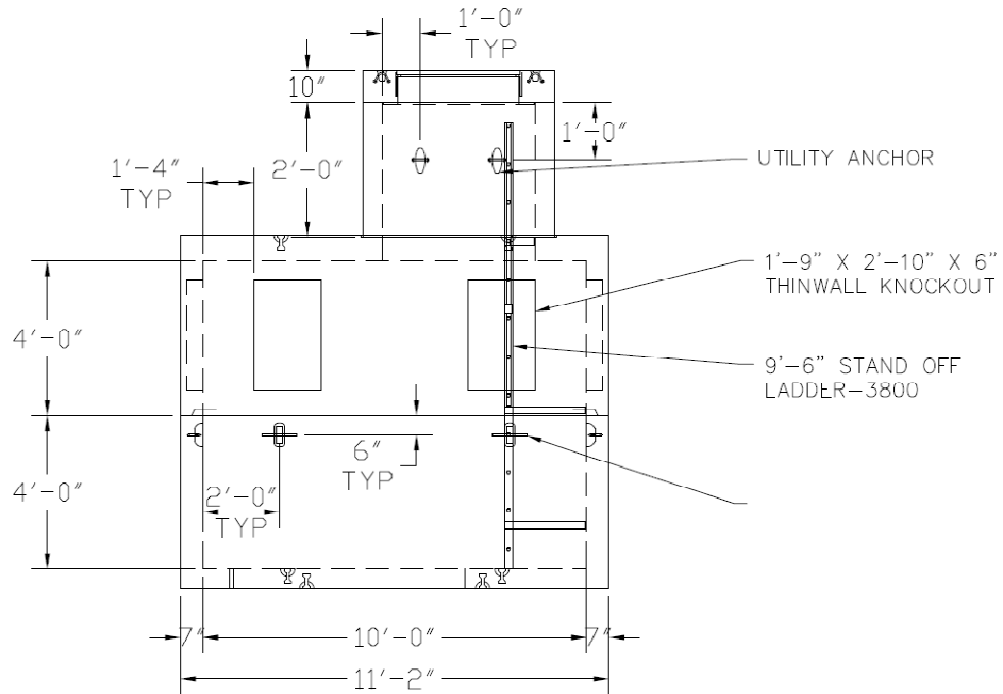


PLAN VIEW OF TOP  
 SCALE: NONE

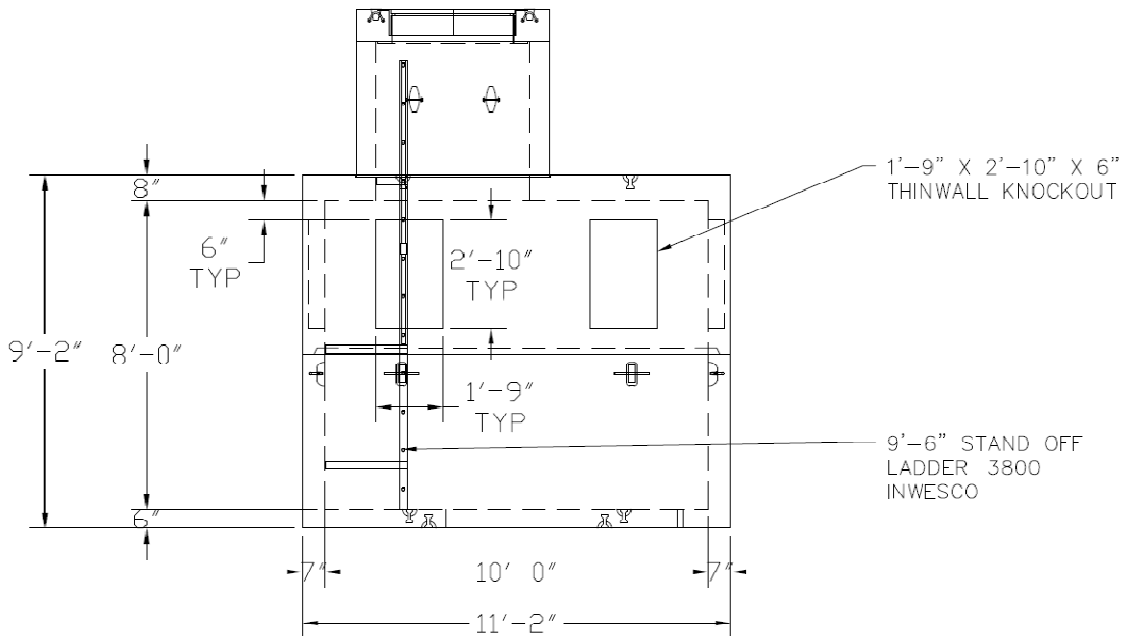


PLAN VIEW OF BOTTOM  
 SCALE: NONE

Medium-Voltage Manhole Detail (1 of 3)  
 Not to Scale

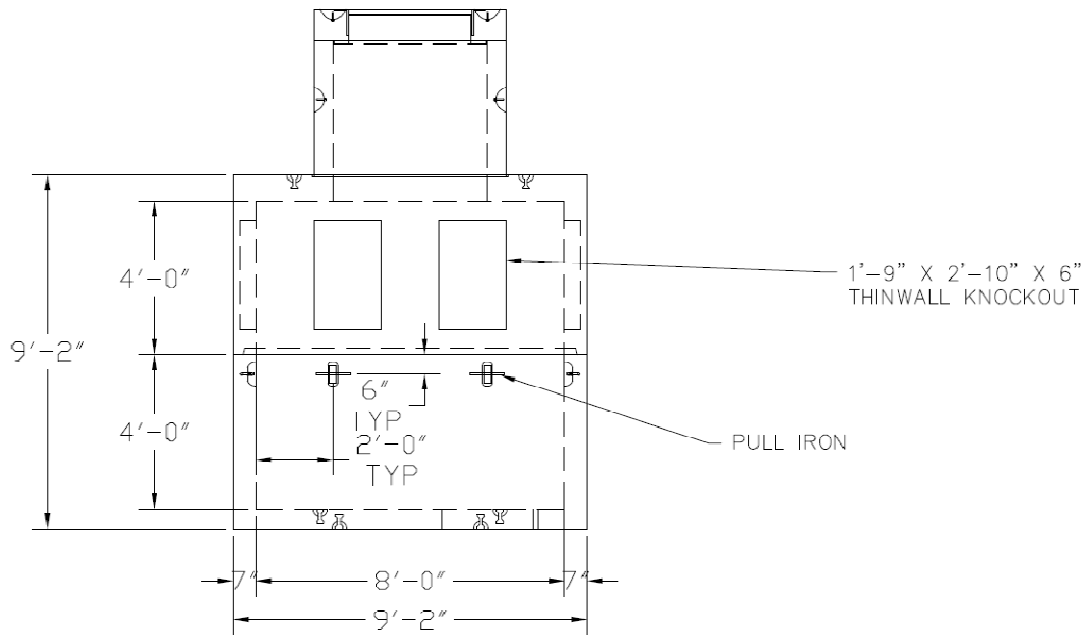


**VIEW A**  
 SCALE: NONE

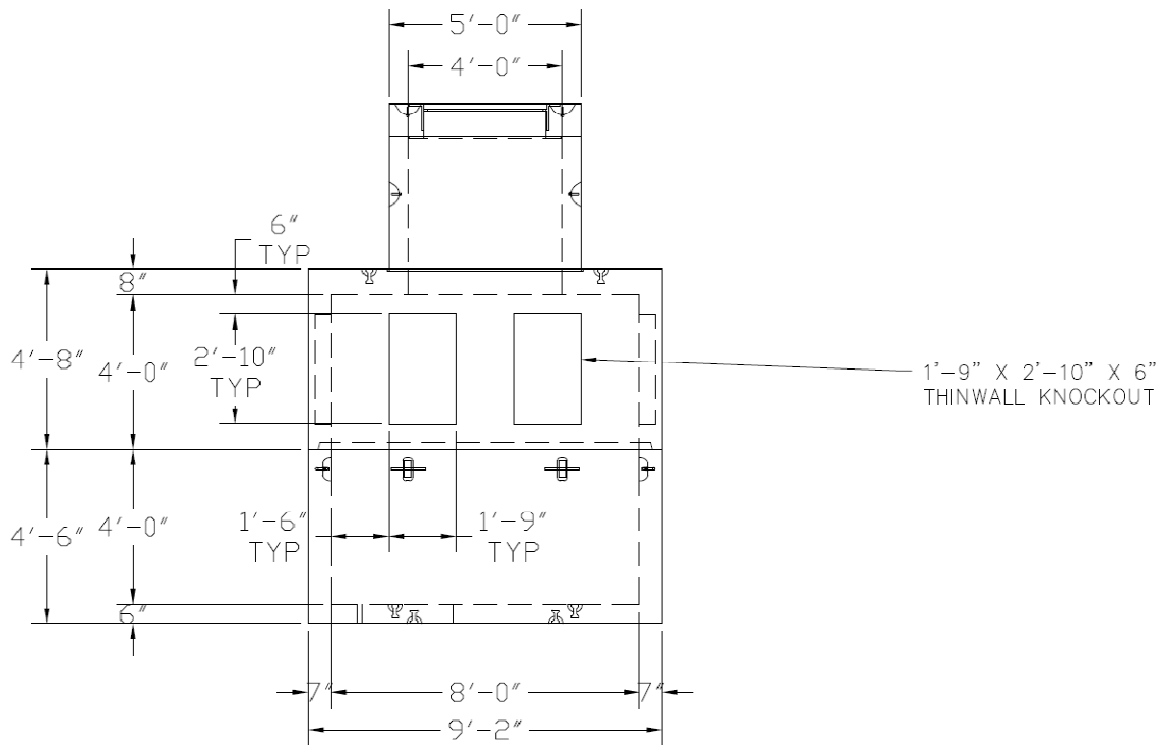


**VIEW C**  
 SCALE: NONE

Medium-Voltage Manhole Detail (2 of 3)  
 Not to Scale



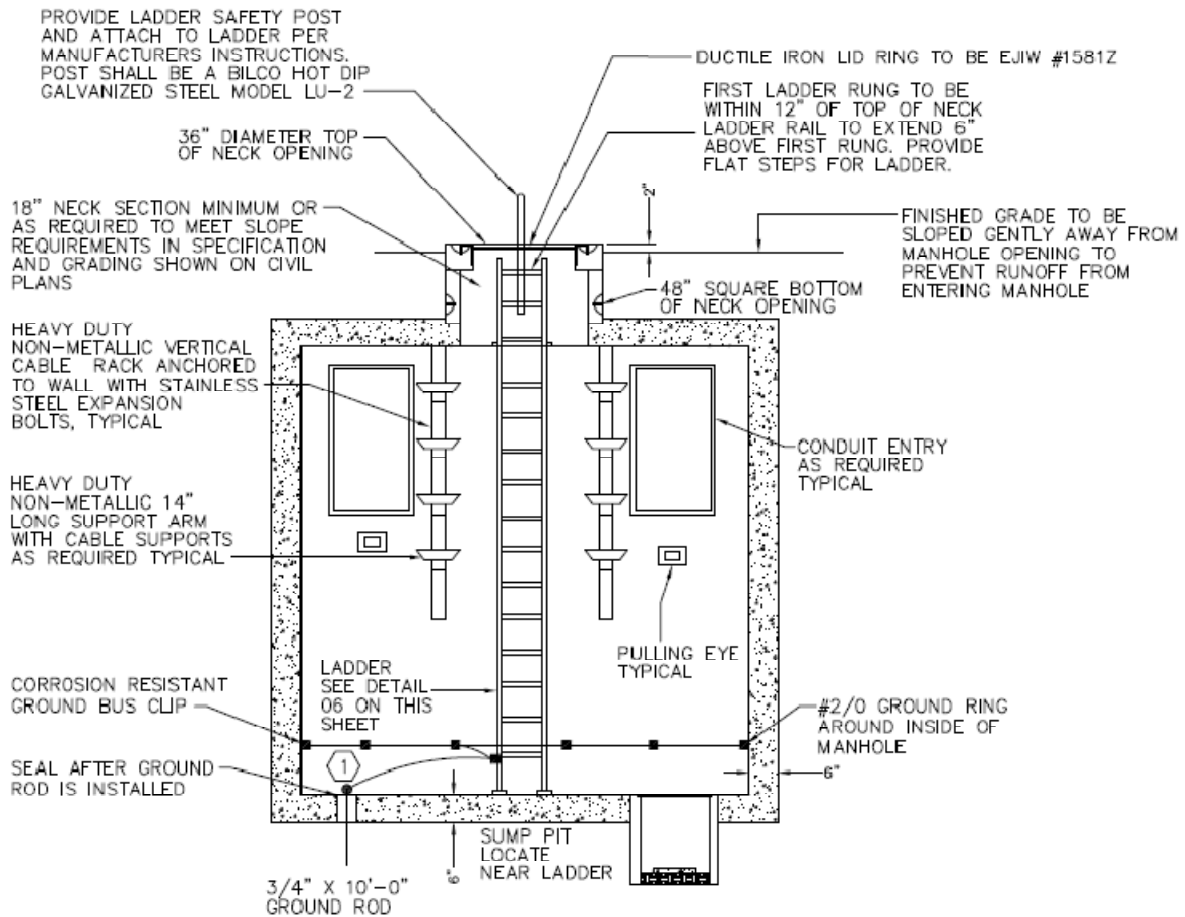
**VIEW B**  
SCALE: NONE



**VIEW D**  
SCALE: NONE

Medium-Voltage Manhole Detail (3 of 3)

Not to Scale

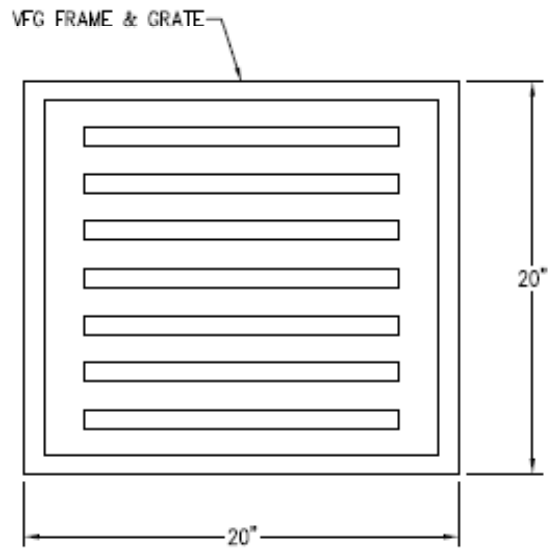
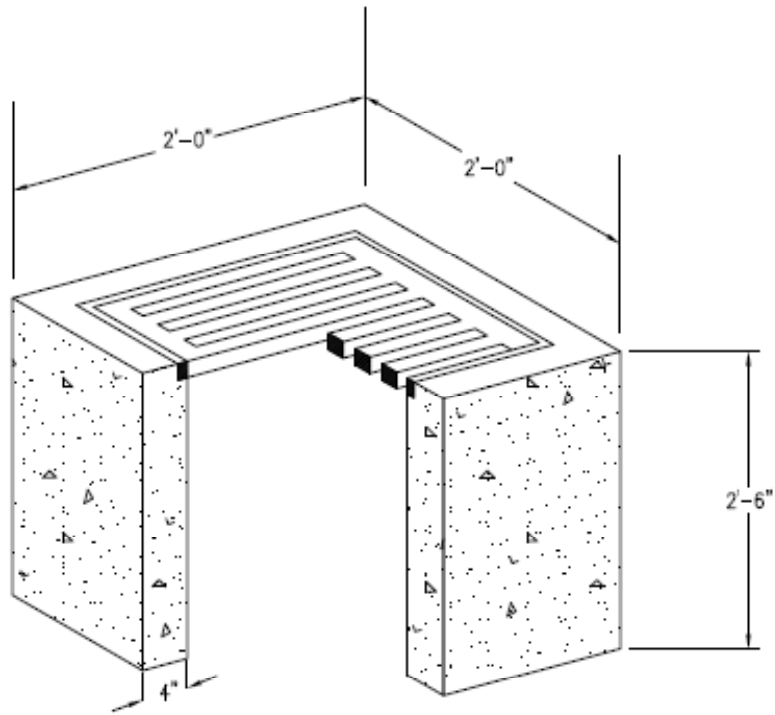


**NOTES:**

1. MANHOLE TO BE DESIGNED FOR H-20 LOADING.
2. SUBBASE FOR PLACEMENT OF MANHOLE TO BE STABILIZED WITH 12" OF CEMENT STABILIZED SAND TO PROVIDE LEVEL SOLID BEARING SURFACE BEFORE INSTALLATION OF MANHOLE.
3. ALL WINDOWS TO BE FURNISHED WITH SMOOTH OUTSIDE WALLS PROVIDING ADDITIONAL STRENGTH TO RESIST BREAKOUT DURING INSTALLATION.
4. MANHOLE COVER TO BE EMBOSSED "ELECTRIC".
5. MANHOLE TO BE INSTALLED SO AS TO PROMOTE NATURAL FLOW TO MANHOLE SUMP. GROUT MAY BE USED TO CORRECT IRREGULARITIES IN FLOOR, IF GROUT IS REQUIRED A RICH GROUT (9 SACKS) SHALL BE USED.

Section – Power Manhole Detail  
Not to Scale

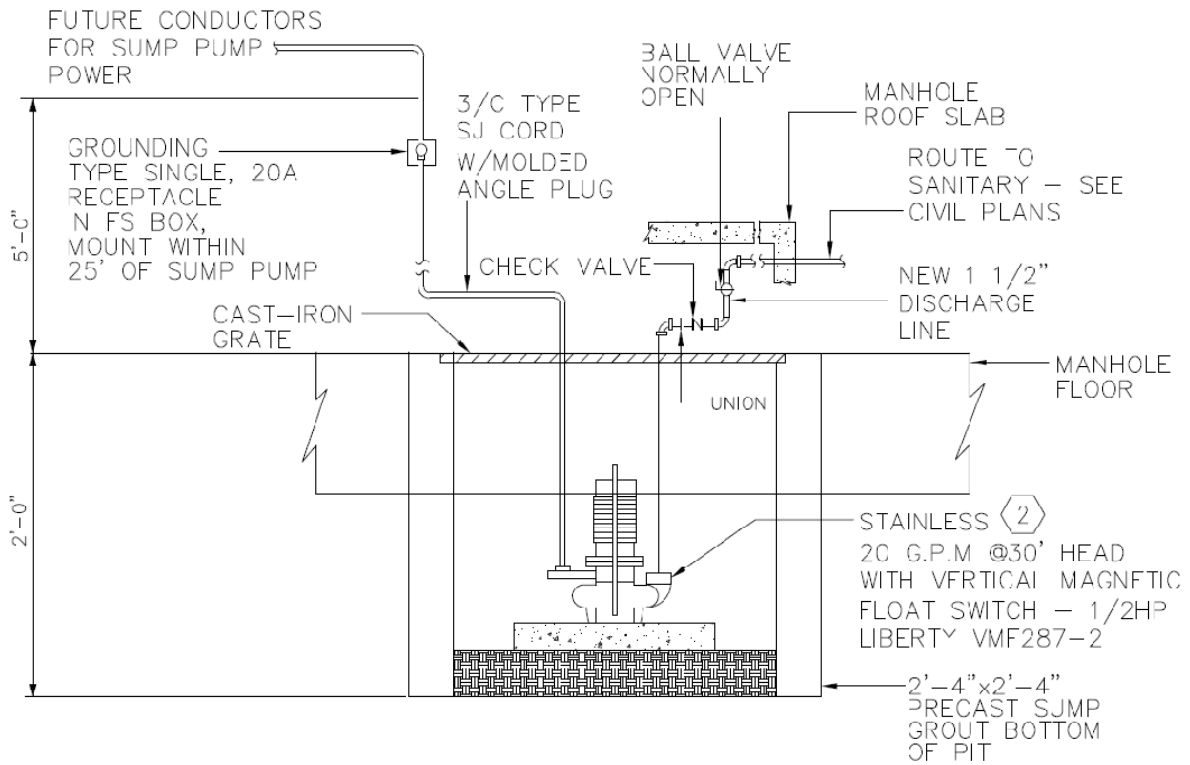




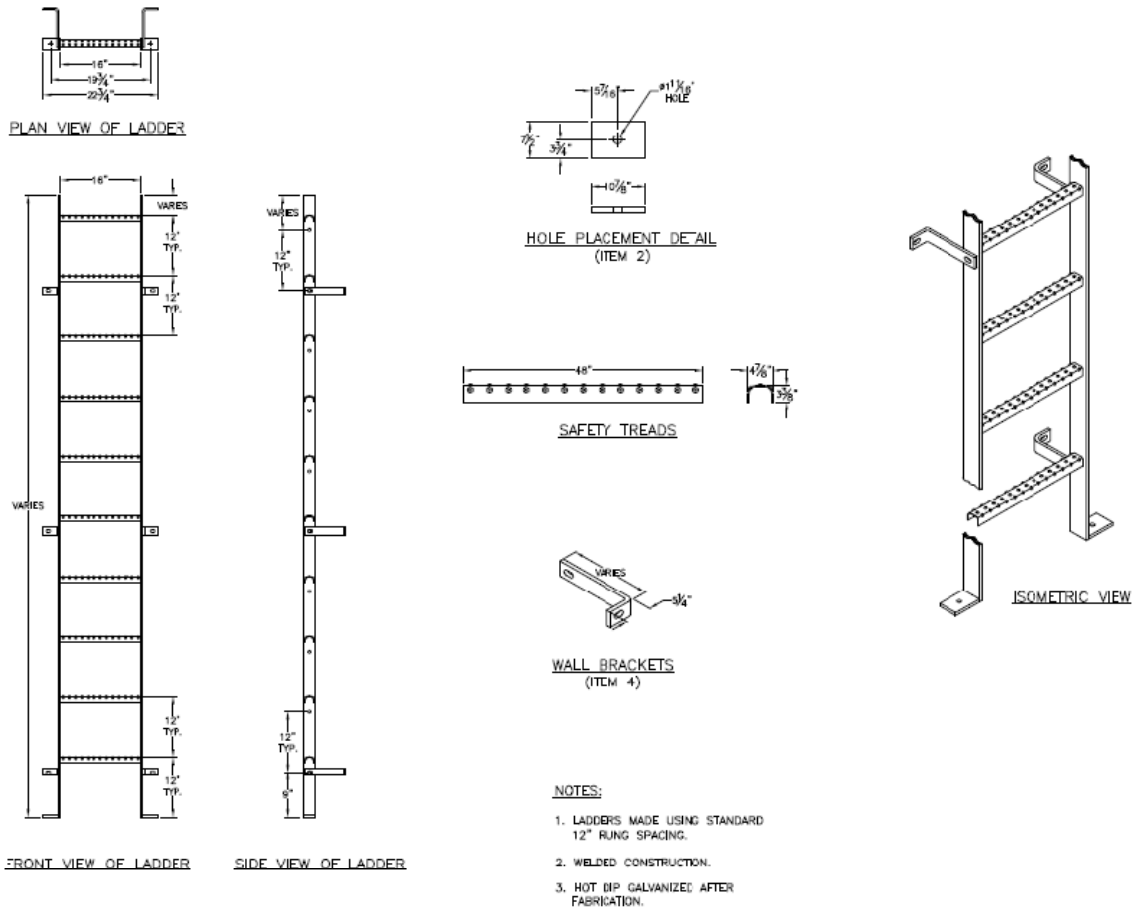
NOTES

1. SUMP PIT SHALL BE FIELD INSTALLED.

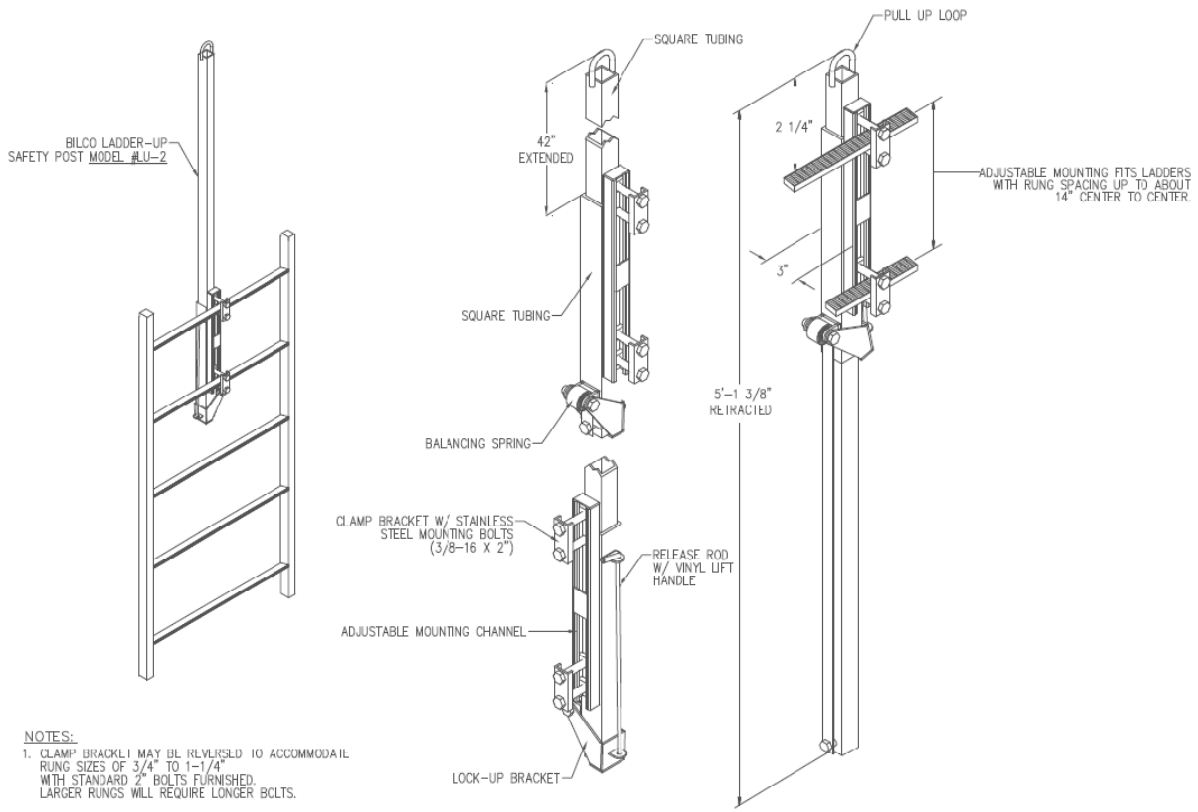
Sump Pit Detail  
Not to Scale



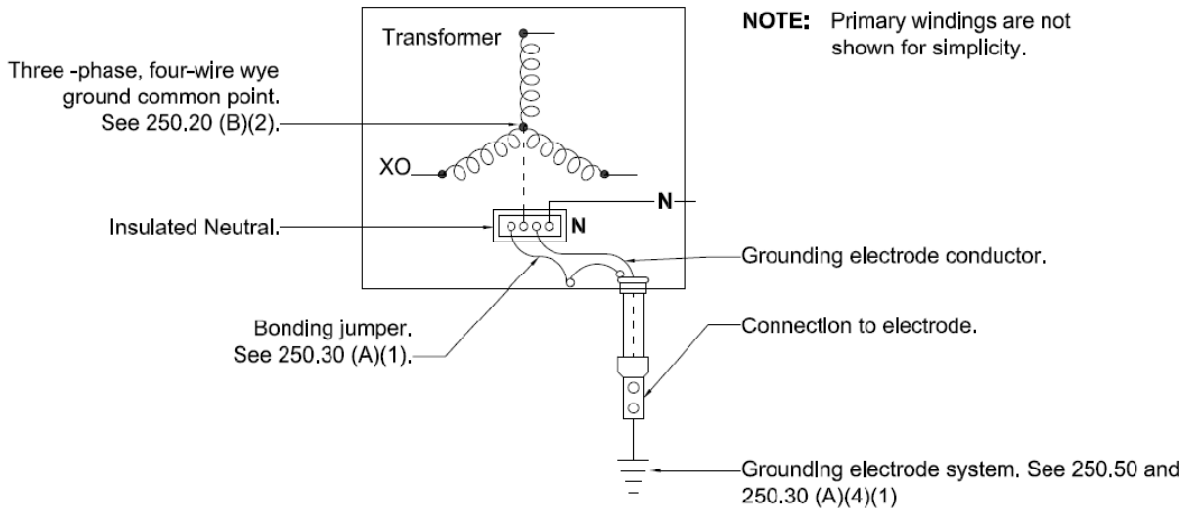
**Sump Pump and Pit Installation Detail**  
 Not to Scale



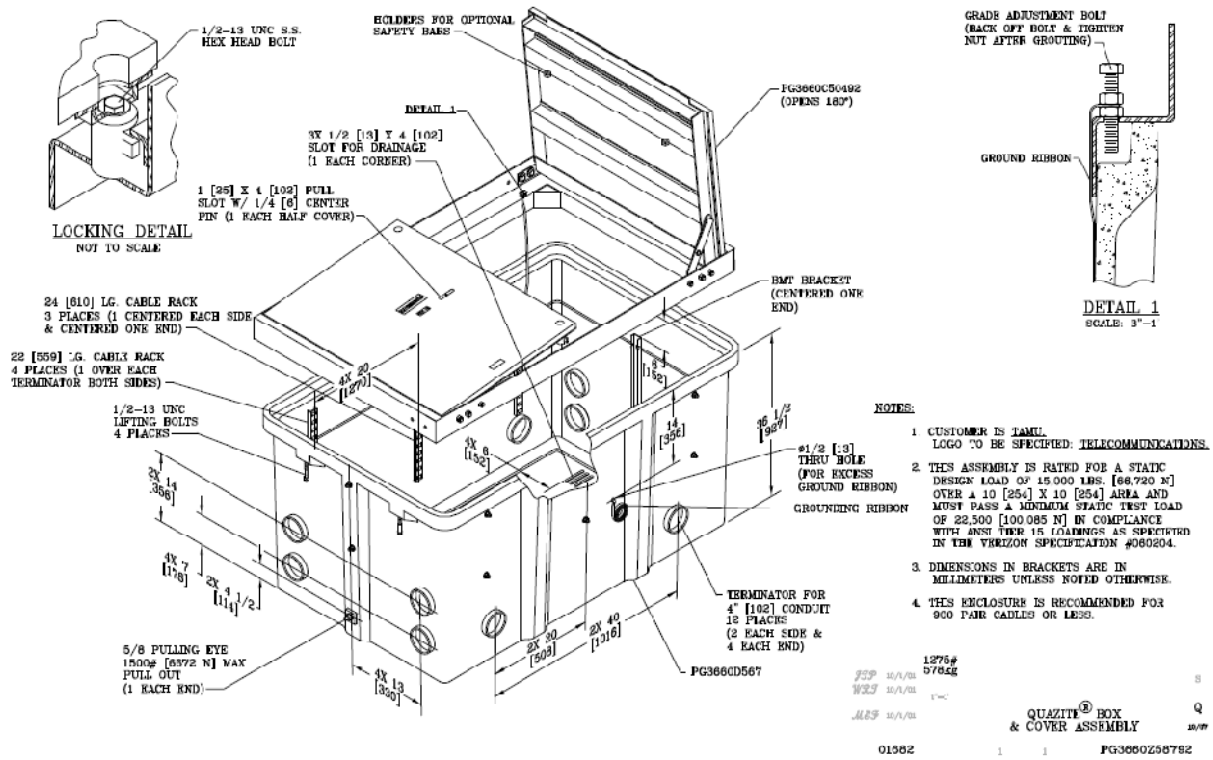
Medium-Voltage Manhole Ladder Detail  
Not to Scale



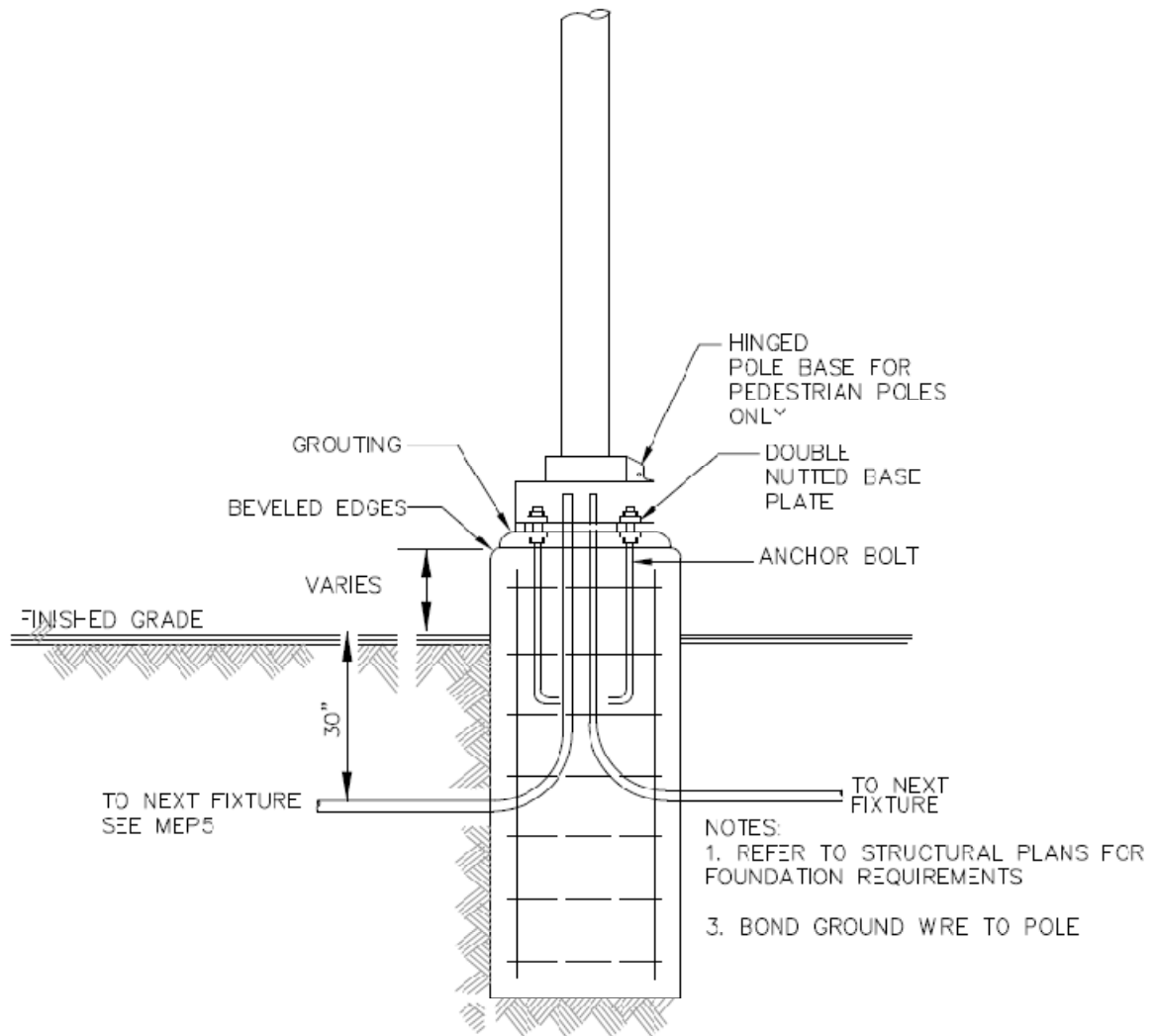
Ladder Up Safety Post Detail  
Not to Scale



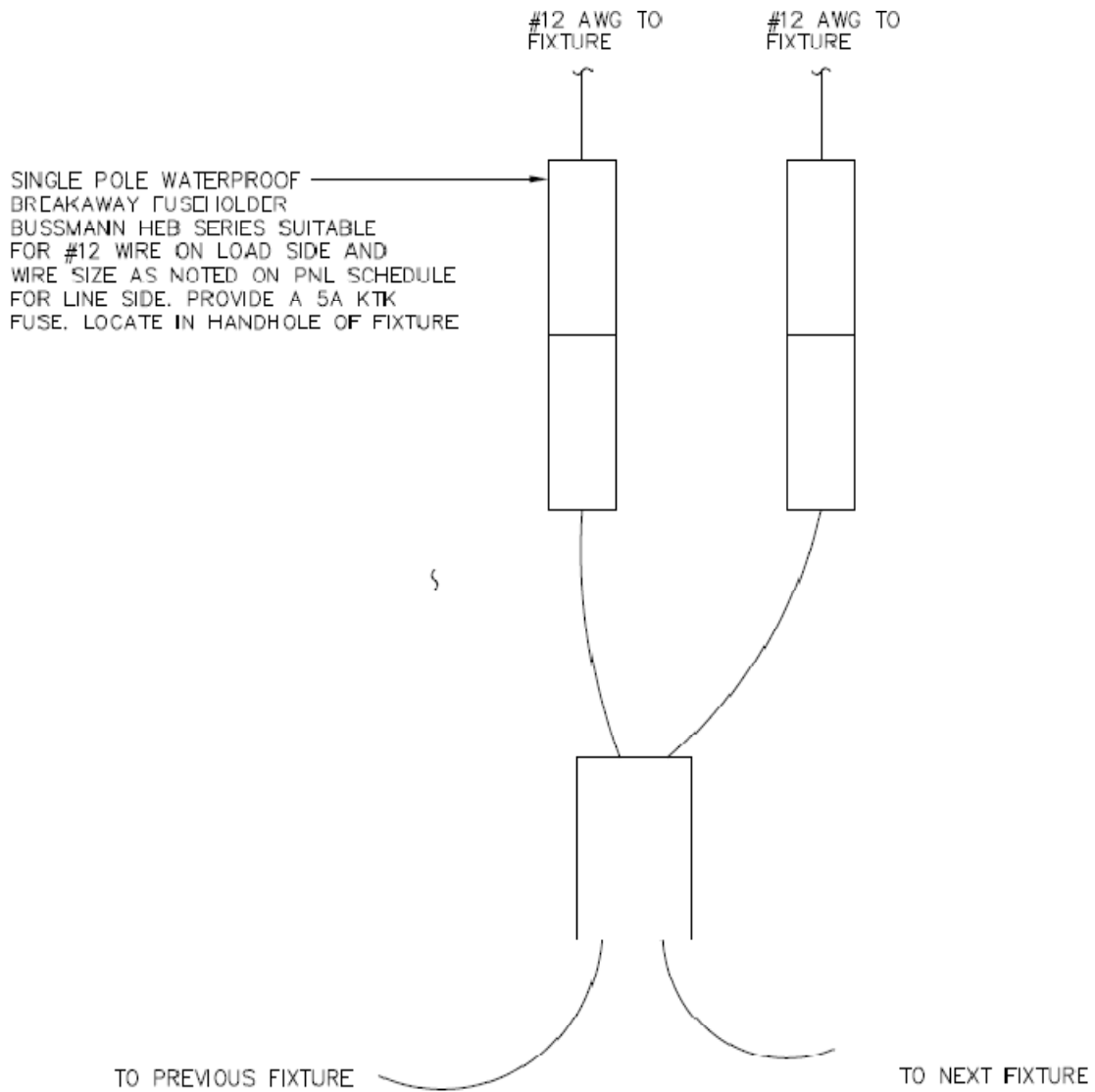
Separately Derived System Grounding and Bonding Detail  
Not to Scale



Telecommunications Pull Box Detail  
Not to Scale



Light Pole Mounting Detail  
Not to Scale



Light Fixture Fusing Detail  
Not to Scale



## General

The Design Process described in this section is primarily for Construction Manager at Risk and Design-Build delivery process. Items specific to Competitive Sealed Proposal or other delivery methods are so noted.

## Integrated Design

Representatives from all parties to the design and construction of the project, the Architect/Engineer team, the Contractor team, the A&M System Member team and the FPC team are expected to work very collaboratively and openly sharing information, including but not limited to BIMs, knowledge and experience from the beginning of Schematic Design through the completion of construction. Representatives from all teams and all disciplines are expected attend and actively participate in all design meetings.

## Program of Requirements Development

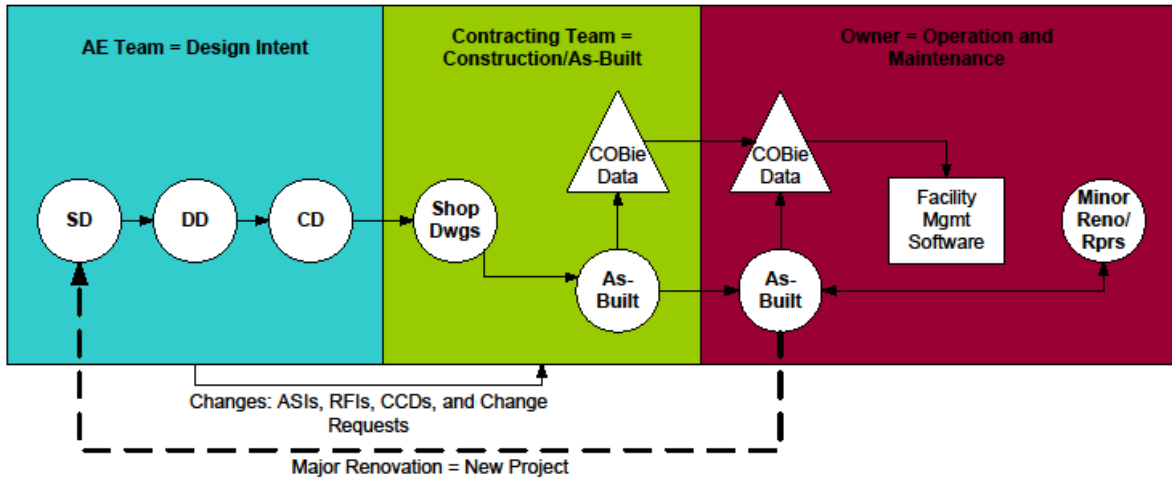
Components of a Program of Requirements (POR)

- Project Goals
- Project Context
- Project Team
- Project Requirements
- Program Summary
- Room Data Sheets
- Project Budget
- Project Schedule
- Project Location
- Meeting Minutes

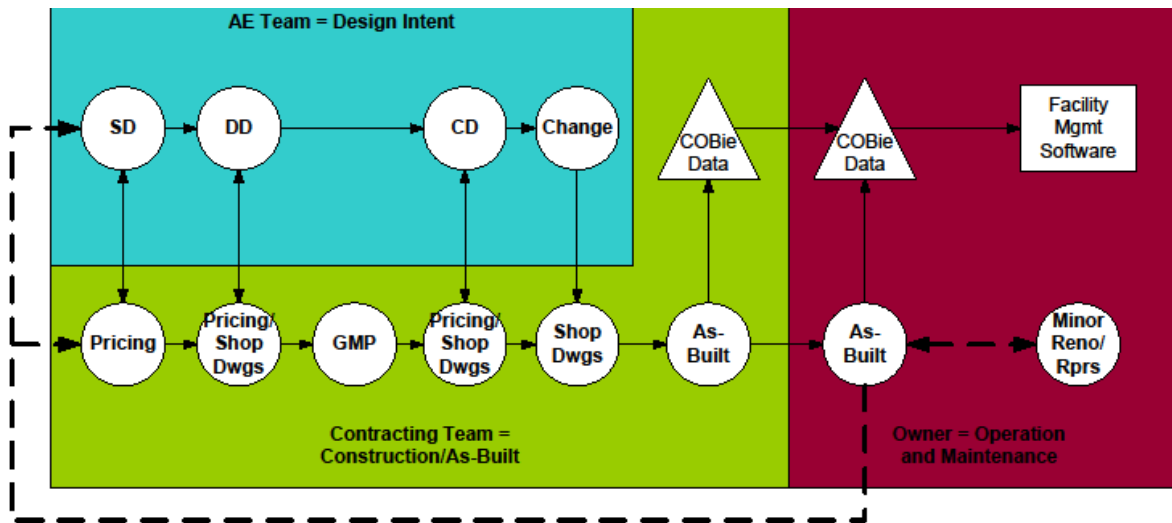
## Overall Design Process

Using BIM in the design process means that there are several are quite a few issues that need to be set up day one of the design process and remain in place and consistent throughout the process, into construction, and closeout.

Using BIM with most delivery methods results in a very linear process, as outlined in the following diagram.



The delivery method we will focus on here is Construction Manager at Risk (CMAR). This process is more collaborative and gives the Construction Manager more input during the design process. Take some time to review the following diagram.



Using BIM means that most decisions on how to set up the project have to be made early on in the process. The following is a summary of many of the issues that need to be implemented or set up early on.

- File/folder naming is important to the organization of the files and sets up the methodology for file archiving.
  - The models being generated are to be used on future projects. The model files should be transmitted in both the native file format of the BIM authoring software as well as optimized IFCs. Free IFC optimizers are available on the internet. See [www.solibri.com](http://www.solibri.com) for an example of one.
  - Each drawing sheet should be delivered in both DWG as well as PDF formats.
  - Specifications should be delivered in both Word Doc format as well as PDFs.

- All files shall be delivered in the proper location as set up in the folder layout which is to be distributed via FPC's website. See the following illustration.
- Set the A/E is to set the project origin. This origin shall be the same for all models. The origin shall relate to a real world survey datum.
- The elevation shall be set according to the real world elevation. That is if the 1st floor elevation is at 230.00' above sea level then the first floor elevation in the model should be the same.
- Models should be split vertically and not horizontally.
- All consultants shall produce BIM models. This includes civil.
- The survey of the model shall also be produced using BIM authoring software. The location and elevation of the utilities shall be indicated on the drawing and modeled.
- The A/E shall work with the owner's team to set the stratification of equipment in the ceiling plenum.
- The A/E shall work with FPC's project manager to establish the project's abbreviated name. For instance the Corp Dorm Renovation project may be known as CDR or the Memorial Student Center Renovation project may be known as MSC.
- The A/E shall work with FPC's project manager to establish room numbering standards and methodologies. This shall remain in place throughout the project so is should not be taken lightly.
- Room area shall be established and updated throughout the project by using standards established by The Higher Education Coordination Board (THECB).
- All equipment that requires access after construction is complete shall have the required clearance modeled along with the equipment.
- All equipment shall be named using an easily identifiable naming standard such as those set forth in the National CAD Standard V4.0. For instance an air handler unit's family or object name should start out with something like AHU then go into more description.
- Equipment objects shall have the minimum parametric attributes:
  - Location, that is room number in which or above which the piece of equipment is located.
  - Manufacturer, at the beginning of the project this is the basis of design manufacturer established by the A/E. In a CMAR project the CM may help to establish the manufacturer that is most likely to be used. This information shall be updated by the CM and its subs.
  - Model number. Again this is based on design intent set by the A/E at the beginning of the project and finalized by the CM at the end of the project.
  - Any pertinent design criteria such as CFM, voltage, watts, volume, velocity, etc. This again is information that shall be updated by the CM and its subs and later by the commissioning (Cx) team.
- Models should be shared frequently by all members of the team. This includes the CM and their subs. Sharing should occur daily if not more frequently to ensure that real time coordination is occurring.
- All efforts shall be taken to reduce the amount of duplication between disciplines. This is more prevalent amongst the A/E team. For instance the architect may show the location of lights then the electrical engineer will show the location of lights but the architect does not remove them from their model. This causes collisions to occur

and also raises questions by the CM and its subs as to which lighting layout is correct. By sharing the various models and using them in addition to the file in which one is working helps to eliminate this sort of problem.

- All trade information shall be contained in a single model not split into multiple models by floor. For instance there should be one model identified as the electrical model. At the beginning of the project this model will belong to the electrical engineer but will then transition to the electrical sub. The model should stay intact as one model and not split into multiple floors. If file size becomes an issue it is preferable to split the building vertically and not horizontally. This split should be consistent through all trades if required.
- All project schedules shall be linked to the model and be generated using parametric data from objects in the model. This link shall remain throughout the project.
- Basic sun shading analysis shall be used to aid in the siting and massing of buildings to help produce efficient buildings that respond to the demands of their geographic location.
- The A/E is required to do clash and collision detection and submit reports addressing the issues found. These reports and models are required at each milestone of the project. Each report shall not be the first run of the report at the milestone. The A/E is required to run the report prior to the due date to address major issues and any false positives that may be found. In the CMAR process the CMAR will be responsible for working with the A/E to run the reports. It is understood that reports run during Schematic Design will generate little data that is they should generate little data.
- The MEP consultant is required to have a person that is responsible for the coordination and design of the various disciplines at coordination meetings not just one overall project manager.
- The BIMs should be used to generate quick images for use in explaining the spaces to the clients. Elaborate renderings are not always required.
- The model files shall be transmitted with object/family and IFC libraries.

### Programming and Space Verification

The use of BIM allows us to create and verify program and programmatic requirements. This also means that the following parametric information must be associated with spaces/zones to be able to extract and compare it to the program. The data may also be used later for submission to THECB, Use BIM to assign and then extract the following parametric data from the model and compare it to the program:

- Room names
- Room numbers
- Room occupancy type
- Room maximum occupancy number
- Departmental information associated with spaces. All spaces shall be assigned a department. The department may also identify circulation and mechanical spaces as well.
- Floor/level of all rooms and spaces

- Three digit room type codes
- Two digit room use code
- Two digit part of system code
- All departmental spaces shall be assigned a color. This color should be the same as that assigned to associated degree type. For instance Architecture is a lavender color and philosophy is blue.
- Square footages of:
  - Rooms (Net)
  - Departmental spaces
  - Overall square footages by floor
  - Circulation area
  - Unassignable area

Square footages and room type codes of spaces should be determined using standards set forth by THECB and the Facilities Inventory and Classification and Procedures Manual distributed by Texas A&M University Office of Facilities Coordination or the appropriate document issued by the member university.

### Schematic Design

The A/E team and the Contractor team shall make professional evaluations of design problems and issues related to this project, analyze the advantages and disadvantages of each evaluation, and recommend cost effective solutions in the Schematic Design phase. The A/E is responsible for the design and arrangement of building components and spaces to provide aesthetically pleasing and functional spaces for the university or agency. Detailed studies by the A/E and Contractor will be required during this design phase to establish the most economical and efficient use of the site, use of materials and construction methods in order to accomplish the System Member's requirements for the project within the approved budget.

It is anticipated that several meetings involving all participants from the A/E team, the Contractor team, the System Member team and the FPC team will be required to develop a design that satisfies the Program of Requirements within the project budget.

For a typical building project the first Schematic Design meeting will explore possible ways to place the building on the site and begin to explore the building mass. Use software to perform day lighting analysis of the buildings. Be sure to take into account obstructions that will cast shadows on the building(s). Prepare massing studies to compare at least three massing schemes. Other Schematic Design meetings will explore arrangements of the individual spaces, including required support spaces, massing and building elevations. The FPC Project Manager shall receive a copy of all presentation materials a minimum of two (2) days prior to each of these Schematic Design meetings. Each Schematic Design meeting may involve multiple presentations to various groups and committees. Refer to the FPC Project Manager for specifics of each Schematic Design presentation.

Drawings for these first Schematic Design meetings can be in rough form, such as butter-paper sketches, since revisions will probably occur. Computer imaging and modeling is encouraged. Hardcopies of all concepts to be presented are required. All members from the A/E team and the Contractor team shall be present and participate at these meetings.

At each of these Schematic Design meetings the Project A/E shall prepare and present a minimum of three (3) different schemes. At the end of each of the meetings the Project A/E will have a direction from the Owner and User as to a design direction for the next Schematic Design meeting.

The final Schematic Design review meeting will determine the arrangements of all building spaces as well as the exterior appearance of the building. The final Schematic Design review meeting will occur a minimum of one (1) week after the submission of all required materials.

The AE and CM shall review construction sequencing. Once the sequencing has been established the AEC shall review and establish any special drawing packages that will be required to begin construction in a timely manner. The drawings required for each package shall be reviewed and documented to ensure that the required drawings are completed and submitted when they are needed.

These early design meetings are a good time for the AEC to review any special project requirements or layout of equipment. For instance the team shall establish a preliminary ceiling plenum stratification strategy by which the AE shall stack building services in the ceiling plenum or leave clearances for ceiling mounted equipment.

A component of Schematic Design will be, in conjunction with the contractor on CMAR and D-B projects, to identify an early release drawings and specifications that can be ready for construction after the approval of the GMP.

Some projects may be able to accomplish Schematic Design in fewer meetings; other projects may take more meetings. The A/E will not proceed to Design Development until all requirements for Schematic Design have been satisfied and approval of Schematic Design has been received.

### **Minimum Requirements for final Schematic Design Submittal**

#### **Drawings**

##### **General**

- All sheets shall have a text scale and graphic scale.
- All applicable sheets shall have a north arrow in a consistent orientation.
- If the site plan(s) and/or floor plan(s) is divided over multiple sheets then a key

map near the title block is required.

- Plotted sheet size cannot exceed ANSI E Size Sheet (34" by 44")
- All text shall be minimum 1/8" when plotted to full size. Text will then be legible on half size sets of drawings.

### Hazardous Materials

- Plan(s) showing location of hazardous materials found during survey.

### Civil

- Site plan(s) at the same scale and orientation as the architectural site plan showing existing and new vehicular and pedestrian circulation, existing and new civil utilities, site drainage areas and calculations of runoff, existing and new contours, existing and new site features, limits of construction and construction staging area.

### Landscape

- Site plan(s) at the same scale and orientation as other site plan(s) showing existing and new planting, existing and new irrigation zones and other site features.

### Structural

- Floor plan of all levels showing column grid, preliminary location of beams with sizes, location of openings and shear walls and floor depressions.
- Preliminary foundation plan
- Preliminary roof framing plan showing major roof slopes.

### Architectural

- Architectural site plan showing all existing and new site features as well as limits of construction and construction staging area.
- Floor plan of all levels showing fire walls, hazard level occupancies and travel distances.
- Floor plan of all levels showing room names, capacity information (occupancy), relative wall thicknesses, door swings, fixed casework and equipment, floor elevation, column grid, wall fire ratings, travel distances.
- Floor plan of all areas showing room names, preliminary furnishings and movable equipment, indication of floor and wall finishes.
- All elevations showing materials, floor elevations, fenestration, exposed mechanical and electrical equipment, finish grades and significant site features
- Major building sections showing relative thickness of floors and walls, floor elevations, finish grades, room names, and significant mechanical and electrical

- equipment.
- Exterior and interior perspectives and/or animations to illustrate design.

### Equipment

- Floor plan of typical laboratories showing laboratory casework and laboratory equipment.

### Plumbing

- Floor plan of all levels showing all plumbing equipment and preliminary routing of main horizontal and vertical runs.

### Mechanical

- Site plan(s) at the same scale and orientation as other site plan(s) showing existing and new thermal and gas lines as well as limits of construction.
- Typical enlarged mechanical room plan showing equipment and required maintenance access.

### Electrical

- Site plan(s) at the same scale and orientation as other site plan(s) showing existing and new electrical distribution as well as limits of construction and construction staging area.
- Typical enlarged electrical room plans showing equipment and code required access
- One line diagram of electrical system

### Telecommunications

- Site plan(s) at the same scale and orientation as other site plan(s) showing existing and new telecommunications, data and cable television distribution as well as limits of construction.
- Floor plan showing typical means of cable distribution.
- Typical enlarged data/telecomm room plan showing equipment and access.
- Typical enlarged plans showing location of audio-visual equipment.
- One line diagram of data, telecommunications, broadband distribution and audio-visual systems.

## Reports

Reports shall be on letter size paper and all bound together in a three-ring binder or spiral bound. All reports shall also be delivered in PDF format as well as Microsoft Word format.



## Basis of Design

The Basis of Design is a narrative description of the project containing the basic information, criteria, logic, major decisions, evaluations and considerations developed in the following applicable categories to prepare the Schematic Design submittal.

- Hazardous Materials Survey Narrative
- Civil and Landscape Design Narrative
- Structural Design Narrative
- Architectural Design Narrative
- Mechanical Design Narrative
- Plumbing Design Narrative
- Electrical Design Narrative
- Data/Telecommunications Design Narrative
- Audio Visual Design Narrative
- Sustainable Design Narrative using LEED 2009 Checklist
- Listing and size of spaces comparing POR with Schematic Design

## Cost Estimate

- Cost estimate in Masterformat 2004 format.

## Completion of Schematic Design

Completed final Schematic Design documents are a result of a completed product and are not a function of time or duration of work.

Final Schematic Design documents that are “on average” 100% complete are not acceptable.

Upon completion of Schematic Design the following are established

- The project scope, form and spatial relationships are defined.
- The selection and initial design of major building systems such as exterior envelope, structure, mechanical, plumbing and electrical are finalized.
- A preliminary construction schedule is established.
- The project as defined is achievable within the established Amount Available for the Construction Contract based on continuous input from the Construction Manager at Risk.
- An early release package is identified on CMAR and D-B projects.

## Design Development

The approved Schematic Design shall be developed into Design Development documents sufficient to fully reveal all aspects of the project. This will include all items to meet the

System Member's needs, and development of all facility components to fully illustrate the proposed aesthetics, construction, systems, utilities, services, and accessories.

Between the Schematic Design approval and the submission of Design Development most projects will require various meetings to identify the full requirements for basic components of the design as well as special or unique components such as data/telecommunications, audio visual systems, security systems, food service requirements, laboratory design, etc. It is anticipated that these meetings will occur, at a minimum, monthly.

Results of these meetings must be documented in a narrative describing systems and identifying the scope that will be in the project.

All submitted documents shall be complete and coordinated between design disciplines.

All documents will address all comments from Schematic Design phase.

When 100% design development documents are available for review, the following should be submitted to FM Global Plan Review Services for comment.

- Proposed building dimensions, finished floor elevations, surrounding contour elevations plan, number of stories, etc.

- Roof Construction Design & Assembly Requirements (including geographic area factors (rainfall, wind speed, etc.), proposed safety factors, construction importance factor, etc.)

- Fire Protection Design Requirements

- Project specifications document, if differ from the "Facilities Design Guidelines" document.

A basic project review letter will be completed by FM Global Plan Review or the FM Global project engineer to ensure the project successfully incorporates appropriate criteria according to applicable FM Global Standards.

The AEC team shall review the drawings required for multiple packages, if required, to ensure that the required drawing list is still accurate and that it is still valid. This is the time to modify the required list of drawings for the early release drawing sets.

If a contracting team is involved during the design phases of the project the BIMs shall be forwarded to them so that they may begin the process of creating submittal/shop drawings.

## Minimum Requirements for Design Development Submittal

(Includes requirements for Schematic Design Submittal)

### Drawings

#### General

- General Information Sheet(s) showing design criteria, net and gross square foot per floor, legend of symbols, abbreviations, drawing conventions, vicinity map & project location map.

#### Hazardous Materials

- Plan(s) showing location of hazardous materials found during survey.

#### Civil

- Demolition Site Plan containing all site demolition.
- Overall site plan(s) showing all new civil construction with demolished items removed including spot elevations and dimensions.
- Separate plans showing site grading.
- Separate plans showing new vehicular paving with jointing and dimensions.
- Separate plans showing pedestrian paving with jointing and dimensions.
- Composite utility map including site mechanical, electrical and telecommunications.
- Separate plan and profile sheets for site water, sanitary and storm drainage.
- Drainage plan with calculations.
- SWPPP plan and details.
- Typical detail sheets.

#### Landscape

- Overall site plan(s) showing all new landscape construction with demolished items removed.
- Separate plans showing landscape features with spot elevations and dimensions.
- Separate plans showing new plantings.
- Separate plans showing new irrigation areas with type of heads and flow rates.
- Typical detail sheets.

#### Structural

- Foundation plan with pier sizes.

- Crawl Space grading plan showing drainage.
- Floor plan of all levels showing column grid, location of beams and shear walls.
- Column and beam schedules.
- Typical detail sheets.

### Architectural

- Floor plan of all levels showing room names, room numbers, capacity information (occupancy), actual wall thicknesses, floor elevation, structural grid, equipment, casework, vertical transportation and dimensions.
- Floor plan of all levels showing fire protection elements and egress plan with travel distances
- Floor plan of all areas showing room names, room numbers, all furnishings and equipment, indication of finishes
- Reflected ceiling plans
- Roof plan showing major rooftop equipment
- Interior Finish Schedules
- Door Schedules
- Window/Glazing Schedules
- All elevations showing materials, floor elevations, exposed mechanical and electrical equipment, finish grades and significant site features
- Interior elevations of typical spaces like restrooms and casework and major spaces like lobbies and ballrooms.
- Major building sections showing actual thickness of floors and walls, floor elevations, finish grades, room names, and significant mechanical and electrical equipment.
- Typical wall sections and details
- Enlarged stairways plan and section with railing details
- Enlarged plan of restrooms with interior elevations
- Enlarged plan and interior elevations of auditoriums and tiered lecture halls
- Typical detail sheets.

### Equipment

- Floor plan of all laboratories showing laboratory casework and laboratory equipment.
- Enlarged plan and elevations of typical laboratory spaces

### Plumbing

- Floor plan of all levels showing all plumbing fixtures/equipment and routing of horizontal and vertical runs
- Details of major equipment and special conditions.

### Mechanical

- Site plan(s) at the same scale as other site plan(s) showing existing and new thermal and gas lines as well as limits of construction and construction staging area.
- Floor plans showing single line duct layout for supply air, return air and exhaust air and location of mixing boxes, coils, dampers, etc
- Enlarged mechanical room plans showing equipment, maintenance access
- Preliminary mechanical equipment schedules
- Typical details

### Electrical

- Site plan(s) at the same scale as other site plan(s) showing existing and new electrical distribution as well as limits of construction and construction staging area.
- Floor plans showing typical light fixture layouts.
- Floor plans showing typical power outlet layouts
- Enlarged electrical room plans showing equipment and code required access
- One line diagram of electrical system

### Telecommunications

- Site plan(s) at the same scale as other site plan(s) showing existing and new telecommunications, data and cable television distribution as well as limits of construction and construction staging area.
- Floor plans showing means of cable distribution location of all devices and outlets
- Enlarged data/telecomm room plan showing equipment and access
- Enlarged plans showing location of audio-visual equipment
- One line diagram of data and telecomm systems

## Reports

### Basis of Design

The Basis of Design report from Schematic Design shall be updated to include the basic information, criteria, logic, major decisions, evaluations and considerations developed in the following applicable categories to prepare the Design Development submittal.

- Hazardous Materials Survey Narrative
- Civil and Landscape Design Narrative
- Structural Design Narrative
- Architectural Design Narrative
- Interior Design Narrative

- Mechanical Design Narrative
- Plumbing Design Narrative
- Electrical Design Narrative
- Data/Telecommunications Design Narrative
- Audio Visual Design Narrative
- Sustainable Design Narrative using LEED 2009 Checklist
- Listing and size of spaces comparing POR with Schematic Design and Design Development
- Code Analysis
  - Life Safety Code Analysis: Provide a code analysis of the design utilizing the Life Safety Code, latest edition (NFPA 101) and all referenced codes.
  - Building Code Analysis: Provide a code analysis of the design utilizing the International Building Code, latest edition covering only those elements not covered by the Life Safety Code (no duplicate items).
- Energy Conservation
  - Provide a report on energy conservation provisions at Design Development that shall consist of compliance documentation that the building envelope meets the code. The report shall also include the manufacturer's performance data for building envelope components. The report shall address all other code sections including HVAC, service water heating, power, lighting and other equipment.

To summarize the report shall cover the following ASHRAE 90.1 applicable areas and include all Compliance forms:

- 5.0 Envelope
- 6.0 HVAC
- 7.0 Service Water Heating
- 8.0 Power (Specification Item)
- 9.0 Lighting
- 10.0 Other Equipment (Specification Item)

Note: 8.0 and 10.0 will only be indicated in the project specifications.

OR

- 11.0 Energy Cost Budget Method

The SECO Compliance Certification form(s) shall be included in the front of the report. There maybe one or more certification forms, depending on how many separate professionals take responsibility for the various disciplines. The Certification form must be preliminary at this point in the design.

- Life Cycle Cost Analysis
- Wind Tunnel Analysis
- Design Calculations
- Schedule of all recommended construction material testing. The schedules shall contain item tested, recommended test, frequency of test, estimated number of test, sampling method, testing method and acceptance criteria.
- Clash and collision detection report. This report shall consist of the report run after a preliminary run of the report which identifies issues that are addressed before running the final DD report for submittal. The A/E is responsible for

generating this report in the absence of a contracting team. When a contracting team is part of the design phases they shall be responsible for running and vetting the report.

### Specifications

- Specifications for significant architectural materials and engineering systems and equipment indicating quality of materials used in project

### Cost Estimate

- Cost estimate in Masterformat 2004 format.

### Completion of Design Development

Completed Design Development documents are a result of a completed product and are not a function of time or duration of work.

Final Design Development documents that are “on average” 100% complete are not acceptable.

Upon completion of Design Development the following are established such that the Construction Manager at Risk can provide a Guaranteed Maximum Price for the project.

- The project scope, form and spatial relationships are finalized.
- The design of all major building systems such as civil, landscape, site utilities, exterior envelope, interior finishes, structure, mechanical, plumbing, electrical and special systems such as telecommunications, data, audio-visual and security are completed.
- A construction schedule is established.
- The project as designed is achievable within the established Amount Available for the Construction Contract based on continuous input from the Construction Manager at Risk.
- Drawings and specifications for an early release package are ready for construction on CMAR and D-B projects.

After approval of the Design Development, the A/E shall furnish the following if required in their agreement:

- Presentation rendering(s) shall consist of an exterior view and/or interior view, drawn in perspective, at a scale of sufficient size (24" x 30" min.) to convey a true representation of the design of the project without distortions that would give misleading impressions. Landscape features together with existing structures should be indicated in a realistic manner. The perspective, professionally prepared, may be rendered in any color media, provided suitable

reproductions can be made from the media selected and it shall be glazed with non glare glass and framed. The frame shall be clear maple in a rectangular profile with dimensions approximately ¾” by 1-1/4”. The name of the project, location, and the name of the A/E shall appear along the lower edge of the perspective. Photographs of models are not acceptable.

- Detailed scale model of the project, in order to give a better understanding of the project as to scale, proportion, mass, or location, indicating fenestration, exterior material, color, trim, walks, drives, parking, and major landscape features. The model shall be mounted on a wood base and protected with a plastic cover. Scale shall be determined by the A/E and the FPC Project Manager; however, the overall dimension should not exceed 48" x 48".
- Presentation animation. The animation shall be fully rendered and be of at least one minute in duration. It shall show the exterior of the building and its site as well as the interior of significant spaces. The resolution shall be 1080P that is a resolution of 1920x1080 at 30 FPS. Light quality shall be ray trace with environmental maps. The textures shall be photorealistic.
- PowerPoint presentation of the project that includes campus plan, site plan, representative floor plan(s), exterior perspective(s) and presentation animation. The PowerPoint will be used by the Facilities Planning and Construction to present the project to the Board of Regents for approval. The slides shall have light colored backgrounds. Black background with white line work is not allowed for PowerPoint presentation.

### Guaranteed Maximum Price

In the CMAR Agreement the Construction Manager is required to submit a Guaranteed Maximum Price Proposal (GMP) based on the Design Development documents and review comments. The GMP is required to be submitted to the FPC Project Manager no later than three (3) weeks after the Design Development Review Meeting. The A/E team is expected to assist the Contractor in developing the GMP.

### Formatting of GMP Documents

The contractor shall submit three (3) copies of the GMP documents each in a three ring binder. The three original signed GMP proposal (Exhibit “E” from the Agreement) shall not be bound in any binder. The GMP documents shall contain the following

Cover of GMP document titles “Guaranteed Maximum Price Proposal for (Project Name), System Member name, Project Number,

Transmittal letter to Chief Financial Officer and Treasurer

Table of Contents

Summary of work including phasing plan, anticipated Notice to Proceed date and Substantial Completion Date.

Copy of Exhibit “E” with Detailed Cost Breakdown

Master Project Schedule showing phasing and all major milestones.



Staffing Plan

### Construction Documents

The approved Design Development documents shall be developed into Construction Documents sufficient to construct the project.

Construction Documents should be submitted to FM Global Plan Review at 50% completion. At this stage, the review confirms the project is in alignment with the Design Development drawings. If significant changes in design have occurred, the intent of the review is to again validate incorporation of key FM Global loss prevention criteria. A re-submittal at the Construction Document Phase would be required. If no major deficiencies are noted, and the only comment or addendum from Plan Review is request for additional information, re-submittal can be addressed in the Shop Drawings & Submittal Phase. This intent shall be communicated by letter to the Plan Review Department if letters are received requesting “additional information.”

### Progress Meetings

The project time schedule and the agreements identify interim progress meetings for review of Construction Documents by System Member and FPC staff generally at 25%, 50% and 75% stages of completion. These meetings do not constitute approval of documents to date, but are for the purpose of answering questions and resolving problems.

During the 25% Construction Documents meeting the Project A/E needs to present to the FPC Project Manager and others at least two interior color schemes for comments. Updates and refinements to the mechanical systems sequence of operation need to be presented for comment. Also, during the review the team must review cut-sheets of all major elements of the design and pieces of equipment with FPC personnel. Examples of these are curtain wall systems, fixed seating, laboratory equipment, audio visual equipment, air handling units, variable air volume boxes, plumbing fixtures and light fixtures. Verify list of items requiring cut-sheets with FPC Project Manager.

During the 50% Construction Documents meeting the Project A/E needs to present to the FPC Project Manager and others the revised interior color scheme for comments. Updates and refinements to the mechanical systems sequence of operation need to be presented for comment. Also, during the review the team must review revised cut-sheets of all major elements of the design and pieces of equipment with FPC personnel.

### 100% Construction Documents Review

Drawings for all divisions of work shall be complete and thorough in all respects, well coordinated, clear, and neatly drawn and in accordance with the Standard of Care for the professions.

Completed Construction Documents are a result of a completed product ready to be used for construction (bidding in the case of CSP delivery) and are not a function of time or duration of work.

Construction Documents shall not be submitted for review until all documents are 100% complete and a complete quality control/coordination check has been made by the Project A/E of all documents.

If the Construction Documents are missing information from team members or drawing sheets are obviously incomplete **do not submit for the 100% Detailed Design review.**

**If cursory review by FPC Project Manager indicates that the documents are not 100% complete, the submittal will be returned for completion.**

A Construction Documents review meeting will be scheduled by the FPC Project Manager to include representatives from the A/E team, the Contractor team, the System Member team and the FPC team for a detailed discussion of comments.

All comments from the Construction Documents review meeting shall be incorporated into the final documents prior to issuance for construction (bidding in the case of CSP delivery). No lengthy addendum to correct the CSP bid documents is acceptable.

### **Bidding and Contract Award Stage (CSP Only)**

The FPC Project Manager will establish the dates for advertising, pre-proposal conference, and proposal opening in consultation with the Project A/E for major projects that utilize the Competitive Sealed Proposal process to procure a Contractor

The CSP process calls for a three (3) part proposal submittal. The proposal parts are identified as:

Part 1 - Competitive Sealed Proposal (Price and Time)

Part 2 - Proposer's Qualifications

Part 3 - HUB Subcontracting Plan

The Project A/E is responsible for helping to secure good competitive proposals. The Project A/E shall oversee the distribution of plans and specifications to general contractors, sub-contractors, suppliers and plan rooms. The Project A/E shall also forward to the FPC Project Manager and all plan rooms on a weekly basis a list of all plan holders.

The Request for Proposals (Bid Advertisement) will be prepared and submitted to the media by the Facilities Planning & Construction Department. A copy of the advertisement along with Division 0 and Division 1 documents will be provided by the

FPC Project Manager to the Project A/E to be included in the Specifications.

In addition to the bound plans and specifications all general contractors shall be provided two (2) loose copies of the Proposal Parts 1 through 3, two (2) loose copies of the Bid Bond form, and one (1) unmailer envelope.

If addenda are issued by the Project A/E, each Addendum sheet shall be dated with pages numbered consecutively.

The Project A/E is responsible for the distribution of all addenda to all plan holders at no additional cost.

The Project A/E and required consultants will attend the Pre-proposal Conference prepared to receive contractor's questions and conduct a site tour if necessary.

The Code "E" Estimate will be prepared and submitted 10 days before receipt of proposals and should reflect any factors affecting the cost that the Project A/E may be able to determine during the bidding period.

The FPC Project Manager will prepare a "Bid Tabulation Form", with assistance from the Project A/E, which lists all expected general contractors and provide sufficient quantities to satisfy the needs at the Bid opening.

The Project A/E is required to attend and assist with the proposal opening procedure to be conducted by the Area Manager. At the conclusion of the proposal opening the Project A/E will be provided one (1) copy of all Part 2 General Contractor Qualifications submittals. The Project A/E will also receive instructions from the Area Manager as to their responsibilities during the contractor evaluation and negotiation period.

The Project A/E will assist in analyzing bid proposals, and provide reports as required concerning the experience, qualifications and references of the bidders, including the named subcontractors and suppliers.

The Project A/E is required to attend the contractor evaluation meeting. The Project A/E shall bring all Part 2 submittals to this meeting. FPC will retain these copies and return them to the contractor.

The Project A/E will assist the Owner during negotiations with the selected Contractor by evaluating the value engineering offerings from the selected Contractor. The A/E will be required to provide any and all documentation required to adequately describe the nature and extent of all accepted value engineering items.

The Project A/E shall assemble all value engineering items from all general contractors and subcontractors into a computer spreadsheet format. This spreadsheet shall to be emailed to the FPC Project Manager prior to the Contractor Evaluation meeting. On the spreadsheet the Project A/E team needs to indicate their opinion (yes, no or maybe) for

each value engineering item. Upon receipt of the spreadsheet System Member and FPC staff will do likewise. At the end of the Contractor evaluation meeting all parties will review the list with comments do determine a final list that will be presented to the first ranked contractor at the first negotiation meeting.

The items that are listed as yes or maybe will be presented to the selected contractor for pricing. At the conclusion of the negotiations with the selected contractor the contractor will prepare a Post Proposal Amendment which will include all value engineering items that are accepted by the Owner. This Post Proposal Amendment will be signed by both the Contractor and the Project A/E and will be included in the construction contract award documentation.

### **Contract Award (CSP Only)**

Immediately following action by the awarding authority, the successful Bidder will be notified of the award by facsimile message from and by the Owner.

The Project A/E will not incorporate any addenda into a "construction set" to be issued to the Contractor. The "Bid Sets" are to be used by all parties to construct the building and it is the responsibility of each party to post all addenda and post proposal amendment information to these "Bid Sets".

The Owner will assemble the Contract Books and secure signatures.

When the contract books are signed and all bonds and insurance is in place the "Notice to Proceed" will be issued to the Contractor by the Chief Financial Officer and Treasurer.

### **A/E Bid Analysis (Competitive Bids Only)**

The A/E will submit to the Owner a bid analysis within 48 hours after the bid opening. This analysis will provide information to the Owner for his consideration in taking action on the bids. The analysis shall be a concise evaluation of the low bidder and his bid amount(s).

Investigate the low bidder's capability, past performance, and experience, particularly in construction similar to subject project. Include this information in the analysis. (The Owner will investigate the financial status of the low bidder.)

Evaluate base Bid and Alternate Bids with respect to the Code "E" Cost Estimate and include in the analysis along with recommendation on acceptance of alternates.

If in the opinion of the Project A/E, the lower bidder is not considered qualified to perform the work, confer with the Area Manager for determination of further action.

As needed, contact the lower bidder and obtain information necessary to prepare cost comparisons of quantity take-offs and price extensions with major elements of the detailed design estimates. Include this comparison and explanations of cost differences in the analysis.

If no bids are received or only one bid is received at the time of opening the Project A/E needs to determine the reasons for lack of bidders.

## Construction

### Pre-construction Conference

After the construction contract has been awarded the FPC Project Manager will establish a date for the Pre-Construction Conference. The Project A/E is expected to attend. The FPC Project Manager will review Owner procedures to accomplish the terms of the construction contract.

### BIM Transition

The A/E will transition the maintenance of the project models to the contracting team once all addenda are issued. From this point forward the contracting team shall be responsible for keeping the model up to date and transitioning the design intent model to a construction/as-built model. The A/E shall still be responsible for issuing model updates for responses to RFIs, and any changes caused due to ASIs, CCD, change requests, or any other change driven by the owner. Installation changes are the responsibility of the contracting team.

### Monthly Progress Meetings

On the same day each month a monthly progress meeting will be held. The Project A/E is expected to attend and be able to answer questions that arise.

The Project A/E is required to attend all monthly construction progress meetings. The A/E team consultants may be required to attend specific monthly meetings based on the project's requirements.

### Color Boards

The Project A/E is required to develop color boards for all exterior and interior colors based on the contractor's manufacturer and/or supplier. The color boards shall be presented to the Director of Project Delivery for approval. After approval the Project A/E will develop a second set of interior colors assembled into a 3-ring binder. The Project A/E shall also generate a listing of all finish materials for the FPC Project Manager and the General Contractor. The AE is responsible for updating all binders throughout the construction phase of the project.

The Project A/E shall also provide an updated listing of all finish materials along with the Record Drawings.

### **Subcontractor Best Value Recommendations**

The contractor is required to submit subcontractor best value recommendations to the Owner for approval for all subcontracts on construction manager at risk and design-build projects. The subcontractor best value recommendations shall be bound in a three ring binder and contain the following

A transmittal letter summarizing the contents of the recommendation package and recommended subcontractors  
Subcontractor evaluation and methodology  
Subcontractor Proposals  
Technical Proposals  
HUB Plans

### **Shop Drawings and Submittals**

All major subs shall be required to work in a BIM authoring software. Typically this includes MEP and fire protection. Other subs that shall be required to produce and update BIMs are structural subs, elevator installation, and subs working on the building skin.

The contracting team is required to update the BIM model to reflect actual products being installed. They are required to update the information required of the AE as well as the addition of serial numbers for equipment. When required by the facility management team RFID and/or Bar Codes shall be affixed to equipment.

The Project A/E team is responsible for the timely review and processing of contractor shop drawings and submittals as indicated in the Uniform General and Supplemental Conditions included in the Design Criteria section of this manual.

Submittals for roof systems and fire protection systems shall be submitted to FM Global for review. Project A/E shall coordinate with FPC Project Manager for this submittal. Project A/E shall include filled out FM Global's Application for Acceptance of Roofing System with roof submittal.

### **Roof Construction & Assembly**

Full submittals for roof construction and assembly should include the following:

FM Approved RoofNav Assembly Number, which can be found at [www.roofnav.com](http://www.roofnav.com). All components within the assembly should be FM Approved, as well as Approved for the given assembly. Contact the Plan Review Department for additional assistance.

Plans and calculations for proposed primary & secondary roof drainage are still needed for review

FM Global Form X2688: Application for Acceptance of Roofing System.

### **Fire Protection System Design**

For Existing Underground Fire Mains & Water Supplies:  
Occupancy Description

Recent water tests and available supply calculations at effective point

For New Underground Fire Mains & Water Supplies:  
Occupancy Description

Recent water tests and available supply calculations at effective point

Full list of all materials and components; FM Approved materials should be utilized. (To check for FM Approval, visit: [www.fmapprovals.com](http://www.fmapprovals.com)) This includes fire pump equipment and controls, above ground tanks, etc.

For Fire Sprinkler Protection

Properly labeled engineering drawings, in accordance with FM Data Sheet 2-0  
Hydraulic calculations for all zones

Full list of all materials and components; trade name and sprinkler identification no. and/or FM Approval no.

Sprinkler Design, in accordance with FM Data Sheet 3-26, and the sprinkler design specified by during the Schematic Design Phase Review.

Special Protection Systems (gaseous, CO<sub>2</sub>, dry chemical, etc.) submissions in full in accordance with FM Data Sheet 2-0, but should include manufacturer, design calculations utilizing manufacturer's approved software

### **Coordination Drawings**

As required in Division 1, Section 01 31 00 the General Contractor is required to produce coordination drawings that will be submitted to the Project A/E for approval. The Project A/E shall review these like all other shop drawings and submittals. The contracting team shall maintain copies of all coordination drawings on site for use on site. Each major sub is required to produce coordination drawings. The lines for the various disciplines shall be unique. There shall be a master coordination drawing at printed in color at 1/4" scale which is a combination of all of the coordination drawings. This

drawing shall be used for field coordination purposes only. It is to be issued to the AE for information purposes only. The coordination drawings shall be kept up to date and reflect any changes made in the field. These changes are to be made in the as-built model and reflected in the record drawings.

### **Substitution Request**

The Project A/E team is responsible for the timely review and approval or rejection of contractor substitution request. Concurrence from FPC Project Manager is required prior to the approval of any substitution request

### **Inspections**

The A/E shall be responsible for transcribing any and all punch lists as prepared by the A/E, its consultants and Owner. The Owner will provide a blank form and sample for A/E to use. The Owner will either convert its punch lists to a WAV, WMS or DSS file and email to the A/E. The Owner's punch list is recorded in Olympus' DSS format compatible with Olympus transcription equipment. The A/E may elect to purchase the Olympus AS 5000 Transcription Kit that comes complete with software.

### **Record Drawings**

The Project contracting team is responsible for recording all items from the contractor's record prints, models, and providing the FPC Project Manager the appropriate Record Drawings as per this manual. The record drawings/model shall be a representation of the as-built condition of the building. They shall reflect changes made due to constructability as well as field coordination issues. The drawings/model shall be accurate reflections of the location of valves, dampers, and any other equipment concealed in the ceiling plenum that may need periodic maintenance.

### **COBie Data**

The contractor is required to extract COBie data from the construction BIM for import into the FM software. The most efficient way to get the COBie data is to ensure that it is input into the BIM as parametric data associated with the various families/objects. The COBie data should be checked for consistency and to ensure that all of the required data fields have been completed. If information is missing it should be updated or added to the model then extracted again. Editing of the COBie data in chart form should be avoided to ensure that the required information is embedded in the model and not just the chart. There are software packages available which can be used to help expedite this process. Note: Costs to use these packages should be included in the project and are not permissible as added cost to the project.

### **FM Global Final Acceptance**

Final acceptance of all projects requires resolution of all outstanding recommendations



on Plan Review letters, and final field acceptance or documentation where required, which can be summarized as follows:

### **Roof Construction & Assembly**

Uplift Testing for built-up roof systems is required for new roofs or roof recovers at campuses within regions that are both (a) prone to hurricanes/tropical storms, and (b) are located within design wind-speed regions of at least 100mph (*Corpus Christi, Galveston, Houston & Kingsville.*) Please provide advanced notification (*minimum 3 weeks*) of Uplift Testing to the FM Global Account Engineer.

Mechanically attached, single-ply membrane roofs cannot be subjected to Uplift Testing, and will only be subject to field review at stages during and concluding installation.

If adequate notice is provided, an FM Global field engineer or the assigned FM Global project engineer will be coordinated to witness the uplift testing to confirm workmanship and final assembly.

FM Acceptance Form X2688: *Application for Acceptance of Roofing System* must be submitted

### **Fire Protection System Design**

FM Acceptance Form X85B Contractor's Material & Test Certificate for Underground Piping must be submitted (*This includes signature of witness to 2-hr hydrostatic testing, conducted in accordance with FM DS3-10 and DS2-0*)

FM Acceptance Form X85A Contractor's Material & Test Certificate for Aboveground Piping must be submitted (*This includes signature of witness to 2-hr hydrostatic testing, conducted in accordance with FM DS2-0 and other applicable standards*)

FM Global engineer conducts Field Acceptance visit as recommended.

### **FM Global Plan Review Submittal Procedures**

A full submittal (hardcopy only) should be sent to the Dallas Plan Review Department:

FM Global – Dallas Operations  
Attn: Carl Funk, Plan Review  
5700 Granite Parkway, Suite 700  
Plano, TX 75023

Each submittal shall include a coversheet with the following information:

Client Name: Texas A&M University System  
Account Number: 01-68099  
FM Global Index Number: (*See Tables Below*)

## Design Process

FM Account Engineer: Allison S. Olsen

Project Name: Campus – FP&C Project ID Number & Project Name

Stage of Project & Submittal Type

i.e. - Schematic Design, Design Development Phase, Construction Document Phase, Construction /Shop Drawings & Submittals Phase, or Final Acceptance

e.g.-“Roof Submittal: Recover Assembly & Drainage Calculations, 1st submittal, 75% Construction Drawings”

Submitter’s Name, Company Name, Contact Information as well as TAMU FP&C Project Contact (in case Plan Review has questions regarding the submittal)

Brief description of the scope of work

Approximate date to expect next submittal or provide a current copy of the project timeline/Gantt chart

| CENTRAL           |  |                                      |                 |
|-------------------|--|--------------------------------------|-----------------|
| FM Global Index # | Location Title                             | Street Address                       | City            |
| 07458338          | Texas A&M University                       | 605 Military Mall                    | College Station |
| 00089454          | John B. Connally Building                  | 301 Tarrow Street                    | College Station |
| 00154686          | A&M System Building                        | 200 Technology Way                   | College Station |
| 00179961          | University Services Building               | 3380 University Drive East           | College Station |
| 00135527          | Riverside Campus                           | 3100 State Highway 47~Building 7091  | Bryan           |
| 00168423          | Texas A&M Health Science Center-Bryan      | 8447 State Highway 47                | Bryan           |
| 07449306          | Texas A&M University - Galveston           | 200 Block Seawall Boulevard          | Galveston       |
| 00154689          | Ft. Crocket Campus                         | 5700 Avenue U                        | Galveston       |
| 07443140          | Prairie View A&M University                | OJ Thomas Street/<br>LW Minor Street | Prairie View    |
| 00123821          | PVAMU School of Nursing                    | 6436 Fannin Street                   | Houston         |
| 07403774          | Health Science Center IBT Building         | 2121 West Holcombe Blvd              | Houston         |
| 00170722          | Texas A&M Health Science Center-Round Rock | 3950 North A W Grimes Blvd           | Round Rock      |
| 07454592          | HSC Temple - Community Education Center    | 2401 South 31st Street               | Temple          |
| 00136385          | HSC Temple - Medical Research Building     | 702 Southwest H K Dodgen Loop        | Temple          |

| SOUTH             |   |                              |                |
|-------------------|---|------------------------------|----------------|
| FM Global Index # | Location Title                                  | Street Address               | City           |
| 07466469          | Texas A&M Corpus Christi                        | 6300 Ocean Drive             | Corpus Christi |
| 00113653          | Texas A&M Kingsville                            | 1050 West Santa Gertrudis    | Kingsville     |
| 00011993          | Texas A&M International University              | 5201 University Boulevard    | Laredo         |
| 00195176          | TAMUS - Gonzales Poultry Diagnostic Lab         | 1162 East Sarah Dewitt Drive | Gonzales       |
| 00136384          | South Texas Center-Health Science Center Temple | 2101 South McColl Road       | McAllen        |
| 00172269          | Citrus Center                                   | 312 N International Blvd     | Weslaco        |
| 203544            | Texas A&M -San Antonio                          |                              | San Antonio    |

| NORTH             |                                  |                             |              |
|-------------------|----------------------------------|-----------------------------|--------------|
| FM Global Index # | Location Title                   | Street Address              | City         |
| 00113650          | Texas A&M Commerce               | Highway 50                  | Commerce     |
| 07430652          | Tarleton State University        | 1401 West Vanderbilt Street | Stephenville |
| 07436425          | West Texas A&M University        | 3301 4th Avenue             | Canyon       |
| 00142647          | West Texas Boiler Location       | 2950 Nance Rd               | Canyon       |
| 00127686          | Texas A&M University - Texarkana | 2600 North Robison Road     | Texarkana    |
| 00150163          | Texarkana Bringle Lake           | 7101 University Ave         | Texarkana    |
| 07418222          | Baylor College of Dentistry      | 3302 Gaston Avenue          | Dallas       |

Plans will be reviewed within 2 weeks of the date they are received; Allow a minimum of 3-4 weeks before your “critical date” to allow for P/O changes, etc. Incomplete submittals will not be given an “Acceptable” rating. After review, FM Global will return comments to submitter and a copy to the System Office of Risk Management and Facilities Planning & Construction Department, the FPC Area Manager, or the local campus project manager for locally managed projects.

Upon review of specifications, drawings, submittal packages, etc., FM Global’s plan review department will issue a letter indicating either “Acceptable” or “Unacceptable.”

This indicates whether or not the submittal has successfully met FM Global design criteria.

**“Acceptable”**: This indicates there were no major issues needing modification. There will likely be minor issues noted in the review letter needing to be addressed, but this specific stage of review does not need to be re-submitted. No specific response to the minor items noted in this letter is needed (unless there are not plans to address these items).

**“Unacceptable”**: This indicates that there were issues in the submittal such that it did not meet FM Global design standards. Therefore, these items need to be revised and a re-submittal of this stage of the review is needed within 30-days of the review. Depending on the type of recommendations in the letter, it may be possible to respond with an acknowledgement that these items will be addressed rather than a full re-submittal. For example:

If the review recommendation was in the design phase that the sprinkler density should be increased from 0.2-gpm/sq ft to 0.3-gpm/sq ft, this could be acknowledged through an e-mail to those copied on the distribution of the FM review letter

If the review recommendation from the roofing submittal was that it was not FM Approved and did not have an FM RoofNav assembly number, a re-submittal would be needed.

## Terms & Definitions

### The Texas A&M University System

The Texas A&M University System is composed of several universities, a health science center and several agencies.

All A&M System construction projects are assigned a two part System Project Number for identification. The first number or prefix is used to indicate which part of the system the project pertains and the last part is a unique four digit number.

The Project Number shall appear on all documents relating to the project. In the event Federal funds are involved, a separate Federal number will be assigned. All references to "Project Number" in that case would refer to both Federal and System numbers.

Prefix numbers are as follows with parenthesis indicating approved abbreviation:

- 01 - The Texas A&M University System (A&M System)
- 02 - Texas A&M University (Texas A&M)
- 03 - Not Used
- 04 - Tarleton State University (Tarleton)
- 05 - Prairie View A&M University (PVAMU)
- 06 - Texas AgriLife Research (AgriLife Research)
- 07 - Texas AgriLife Extension Service (AgriLife Extension)
- 08 - Texas Engineering Experiment Station (TEES)
- 09 - Texas Engineering Extension Service (TEEX)
- 10 - Texas A&M University at Galveston (TAMUG)
- 11 - Texas Forest Service (TFS)
- 12 - Texas Transportation Institute (TTI)
- 13 - Not Used
- 14 - Not Used
- 15 - Texas A&M University-Corpus Christi (A&M-Corpus Christi)
- 16 - Texas A&M International University (TAMIU)
- 17 - Texas A&M University-Kingsville (Texas A&M-Kingsville)
- 18 - West Texas A&M University (WTAMU or West Texas A&M)
- 19 - Not Used
- 20 - Texas Veterinary Medical Diagnostic Laboratory (TVMDL)
- 21 - Texas A&M University-Commerce (A&M-Commerce)
- 22 - Texas A&M University-Texarkana (A&M-Texarkana)
- 23 - The Texas A&M Health Science Center  
(Texas A&M Health Science Center)
- 24 - Texas A&M University-Central Texas
- 25 - Texas A&M University-San Antonio

## General Requirements

### Office of Facilities Planning and Construction

The Office of Facilities Planning and Construction (FPC) is a part of the A&M System Offices (SO) and manages all major construction projects for the A&M System and reports to the Chancellor of the A&M System. For the purposes of this document FPC is also the Owner.

Facilities Planning and Construction is located on the first floor, Suite 1162, of the A&M System Headquarters Building located at 200 Technology Way in College Station.

The Chief Financial Officer and Treasurer is responsible for the administration, planning and construction of projects for the A&M System. The staff consists of the following:

Director of Project Delivery is responsible for coordination of the project delivery process including management of design and construction activities. Project Delivery staff includes:

Area Manager is responsible for the daily coordination and project management of the projects assigned to their teams and for successfully completing all projects in their region of the State.

Architectural Project Manager is responsible for managing the design phase under the leadership of the Area Manager and coordinating the activities of their team in accordance with policies and procedures established by the Department.

Construction Project Manager is responsible for managing the construction phase under the leadership of the Area Manager in accordance with policies and procedures established by the Department.

Project Inspector is responsible for the daily inspection of the Work.

Interior Designer is responsible for managing the furnishings programming, selection and installation and working with the Architectural Project Managers to ensure the designs accommodate the required furnishings.

Area Manager for Engineering is responsible for coordinating the activities of discipline specific System Engineers and Engineering Inspectors to assist the Area Managers during design and construction

System Engineer is responsible for providing discipline specific engineering knowledge to assist the Area Managers and their teams during design and construction.

## General Requirements

Engineering Inspector is responsible for inspecting their discipline specific aspect of the Work.

Director of Project Planning is responsible for preparing the A&M System Capital Plan, assisting the System Members with pre-planning assistance, preparation of all project Program of Requirements and managing assigned campus master plan projects.

Director of Project Controls is responsible for maintaining departmental processes and procedures for project management, maintain the IMPACT project management system and provide assistance to Project Planning and Project Delivery.

### System Offices

#### Office of HUB and Procurement Services

The Office of HUB and Procurement Services is a part of the A&M System Offices and is responsible for identifying and promoting the use of Historically Underutilized Businesses on projects managed by Facilities Planning and Construction. The Office of HUB and Procurement Services will assist the design teams and contractors in meeting their HUB Goals.

HUB and Procurement Services also oversees the procurement of other design and construction related services such as Construction Testing, Commissioning, Air Balancing and Furnishings.

HUB Coordinator is the individual with HUB and Procurement Services that is assigned to assist with projects in a geographic region of the State.

### System Members

Chief Executive Officer is defined as the President of an academic institution (Texas A&M University, Prairie View A&M University, Tarleton State University, Texas A&M University-Corpus Christi, Texas A&M University-Kingsville, Texas A&M International University, West Texas A&M University, Texas A&M University-Commerce, Texas A&M University-Texarkana and Texas A&M Health Science Center) or the Director of other parts of the System.

User or Using Agency is the academic institution or agency that will use the completed facility.

User Coordinator: The individual designated by the User or Using Agency as its representative during the programming, design and construction of the project. The User Coordinator will serve as the contact and representative of the department,

## General Requirements

university or agency and will be responsible for coordinating the procurement of special equipment, telephone installation and scheduling the relocation of equipment and/or personnel to/from the spaces affected by the construction. The User Coordinator has no contractual or approval authority with regards to the design and construction agreements.

### Other Definitions

Project: The term "Project" may include the construction of any building or any structure or any facility or utility appurtenant thereto, including fixed equipment and furnishings thereof, and of any addition to, alteration, rehabilitation or repair of any existing building or any structure, or any facility or utility appurtenant thereto.

Program of Requirements (POR) is prepared for the project by the Project Planning Division, by a firm contracted by FPC to develop the POR or by the Project A/E as a reimbursable service. The POR shall be based on input from the User or Using Agency and/or the User Coordinator and approved by the CEO of the Using Agency. The POR is the single written source of information concerning the scope of the project and the detailed requirements to be achieved by the project. The POR identifies the project specific elements to be included in the new and/or renovated facility. It establishes basic design criteria and shall be verified by the A/E through meetings with the Users during the Schematic Design phase of the project. The POR is to be used in conjunction with the Facility Design Guidelines and the Services Agreement to establish the overall responsibilities of the design and construction team.

The POR generally consists of:

- Project Goals
- Project Context
- Project Team
- Project Requirements
- Program Summary
- Room Data Sheets
- Project Budget
- Project Schedule
- Project Location
- Meeting Minutes

Contractor: The individual, corporation, company, partnership, firm or other organization that has contracted to perform the Work under the Contract with the Owner.

Record Drawings are the contract drawings, modified and/or corrected to incorporate all changes made during construction.



## General Requirements

Additional Definitions can be found in Article I of the "Uniform General and Supplemental Conditions", located in the Appendix section of this manual.

### ADMINISTRATIVE PROCEDURES & REQUIREMENTS

#### General

At anytime during the course of the project the A&M System reserves the right to contract on its own any of the services required to complete the project.

#### Payment Schedule for A/E, CMAR and D-B Services Agreement

Payments to the A/E, CMAR and D-B for work completed will be made in accordance with the Services Agreement. All invoices submitted shall be accompanied by a completed Progress Assessment Report (PAR).

#### Authorization for Reimbursable Services

The Services Agreements contain several items that are reimbursable services. Even though these items are listed in the Services Agreement they still need to be authorized by the Owner prior to execution of the services. The A/E, CMAR and D-B must forward to the FPC Project Manager a proposal for the services with a not to exceed amount from the consultant/vendor. The cover letter should summarize the amount. The FPC Project Manager will review the proposal and if the total amount is within the amount listed in reimbursable services of the Services Agreement the FPC Project Manager will authorize the service in writing. Many of the reimbursable items like site survey, soils investigation and rendering will be authorized with the instruction that there will be one "lump sum" payment made at the successful completion of the task. Other reimbursable items like special consultants, whose work is incorporated into the design documents, will be authorized and the amount will be paid by project milestones as indicated in the A/E Services Agreement or in the proposal acceptance letter.

If the proposed reimbursable services amount exceeds the amount listed in the Services Agreement than the authorization will come from the Director of Project Delivery and the reimbursable amount in the Services Agreement will be modified by a change order to the agreement.

Upon completion of a "lump sum" reimbursable item the A/E, CMAR and D-B must submit an invoice to the FPC Project manager for payment. The invoice must be from the A/E, CMAR and D-B and contain as backup a copy of the consultant/vendor's invoice. The cover letter must indicate that the services have been performed to their satisfaction and are complete.

## General Requirements

If due to extenuating circumstances a “lump sum” reimbursable service is not able to be completed the Owner will entertain a partial payment. The A/E, CMAR and D-B must send a letter to the FPC Project Manager explaining the circumstances, indicating the amount of work complete and suggesting a partial payment amount. The FPC Project Manager will review this request with the Area Manager. Upon the concurrence of the Director of Project Delivery a partial payment will be made.

### Authorization for Additional Services

The Services Agreements states the conditions for which the A/E, CMAR and D-B may receive compensation for additional services.

If the A/E, CMAR or D-B foresees that additional services should be performed because of instructions received, or unusual circumstances, they shall transmit in writing to the FPC Project Manager a statement of the services and a fee proposal for these services. The request will be evaluated by the FPC Project Manager and the Area Manager. The additional services shall not be performed or contracted by the A/E, CMAR or D-B until written authorization is received from the Area Manager or Director of Project Delivery and the Services Agreement has been modified by a change order.

### Approvals/Notifications

At each step in the design process the A/E, CMAR and D-B must receive approval from the Owner prior to proceeding to the next step. These approvals take different forms and can vary due to project complexity. Generally, the A/E, CMAR and D-B will be authorized to proceed by the following:

1. Begin Design: Letter transmitting fully executed Agreement
1. Schematic Design: Approval Letter for Schematic Design
2. Design Development: Approval Letter for Design Development
3. Construction Documents: Approval Letter for Construction Documents and signing of cover sheets by Director of Project Delivery
4. Construction Phase: Issuance of Notice to Proceed with Construction Services

On all projects the Schematic Design approval letter will come from the Area Manager. The larger and more complex projects will have an approval letter that will be first routed through the campus or agency administration for their approval prior to our approval of Schematic Design. This approval routing will also contain letter and/or tabloid size color copies of the project site plan, floor plans and exterior appearance.

The approval process for Design Development begins with an approval letter, along with letter and/or tabloid size color copies of the project site plan, floor plans and exterior appearance, that will be first routed through the campus or agency administration for their approval.

## General Requirements

The approval process for Construction Documents begins with an approval letter, along with letter and/or tabloid size color copies of the project site plan, floor plans and exterior appearance, that will be first routed through the campus or agency administration for their approval.

At a point after the completion of Design Development and prior to the acceptance of a GMP or the award of any construction contract the project will be presented by the Chief Financial Officer and Treasurer to the Board of Regents for approval.

If reviews or approvals of documents are required by Federal agencies, the A/E may be expected to make necessary presentations with Facilities Planning Division's assistance.

### Distribution of Documents

The A/E shall furnish the FPC Project Manager the number of sets of documents as identified in the A/E Agreement at each step of the design process. The documents sent to FPC Project Manager are reviewed by FPC personnel and the documents sent to the User Representative are reviewed by representatives from the using department, Physical Plant personnel, Safety & Health personnel, Campus Police personnel, etc.

### Correspondence and Reports

Communications between all parties involved in the planning and construction of a project is a requisite. Oral communications, instructions, directives, and minutes of conferences shall be confirmed in writing by the A/E and distributed to those involved in the planning and construction within five (5) working days of the meeting date.

The Project Architect/Engineer is expected to provide leadership of all design meetings and provide minutes of each meeting within five (5) working days. The meeting minutes shall separately indicate all decisions made at the meeting and all items requiring a decision, which party has responsibility for the decision and when the decision is required.

All correspondence and reports shall be dated and show clearly the project number, the name of the project, the Part of the System, the location, and the A/E contract number, if pertinent.

All correspondence and reports shall be addressed to the Project Manager of FPC during the design phase and construction Phase.

## General Requirements

### Pending Issues Report

The Project A/E shall prepare and maintain a Pending Issues Report throughout the Schematic Design, Design Development and Construction Documents phases of the project. The report shall document all items requiring decisions on the part of the design team, FPC and the User. The report shall be updated at least monthly during the course of the project and also provided along with meeting minutes from the milestone reviews.

### Data Furnished to A/E

The A/E will be furnished a copy of the Program of Requirements (POR) unless the POR development is included as a reimbursable service in the A/E Agreement, existing campus master plans and other studies and reports, soil investigation reports from surrounding buildings if available, existing utility information and existing building information if the project involves renovation.

### Changes in Design

There shall be no changes made in the Scope of Work, Area Requirements, or Project Cost without approval of the FPC Project Manager. During the design process the A/E shall maintain a listing of all spaces listed in the Program of Requirements and their square footage. The listing will begin with the POR spaces and be updated at each design milestone.

Major changes to the spaces in an approved POR shall be approved by the Using Agency CEO.

### Schedule of Planning

The POR for each Project contains a time schedule indicating dates for all project milestones. It is very important that these dates be followed as close as possible since it can be very difficult to reschedule around all parties existing business schedule. If changes must be made the A/E must notify the FPC Project Manager several weeks in advance. Deviations from the POR time schedule will only be made when mutually agreed to by the User, the A/E and the FPC Project Manager.

Under special conditions, the planning schedule may be dictated by the need for the Owner to place a completed project in service by an established date deadline. This may occur as a result of grant restrictions, land use or deed restrictions, or a critical need for the facility to be placed in operation to meet semester schedules. In this event, a specific construction completion date will be established by the FPC Project Manager, and the various planning stages shall be scheduled from that date.

## General Requirements

Should the A/E find that the dates of the Planning Schedule cannot be met, they shall give prompt notice in writing to the FPC Project Manager.

### Reviews

The review of any drawings and specifications by the Owner and others does not relieve A/E of any responsibility nor do they constitute approval of drawings and specifications to that date.

### Drawing Requirements

The Project A/E shall produce the design for this project using Building Information Model (BIM) authoring software capable of producing IFC compliant files. The Project A/E shall begin using BIM as early in the design process as possible but no later than the drawings required for Design Development submittal. The A/E is encouraged to use BIM to verify compliance with the POR. Maximum drawing sheet size is restricted to ANSI E size - 34" x 44". Lettering is to be of sufficient size so it can be easily read when reproduced full size and half size. Minimum size of letters on any full size printed drawing is 1/8". Use only the standard fonts supplied with the Microsoft Windows OS. On all drawings, provide a graphic scale in addition to the standard inch scale. On all plan sheets provide a north arrow and if a plan is divided over multiple sheets provide a key plan adjacent to the sheet number in the title block. **Do not use the word "PROPOSED" in designating new work.** All work shown on drawings shall be assumed to be new unless designated as existing.

All drawing sheets shall comply with the following sheet numbering format.

|   |   |   |   |   |
|---|---|---|---|---|
| A | - | N | n | n |
|---|---|---|---|---|

Where "A" is the discipline designator, "N" is the drawing sheet type designator, "nn" is the sheet number.

The following are the discipline designators as well as the order the drawings shall be placed in a set.

|   |   |                     |
|---|---|---------------------|
| G | - | General             |
| H | - | Hazardous Materials |
| C | - | Civil               |
| L | - | Landscape           |
| S | - | Structural          |
| A | - | Architectural       |
| I | - | Interiors           |
| Q | - | Equipment           |

## General Requirements

|   |   |                          |
|---|---|--------------------------|
| F | - | Fire Protection          |
| P | - | Plumbing                 |
| M | - | Mechanical               |
| E | - | Electrical               |
| T | - | Telecommunications       |
| R | - | Resource                 |
| X | - | Other Disciplines        |
| Z | - | Contractor/Shop Drawings |

The following are the drawing sheet type designator.

|   |   |                        |
|---|---|------------------------|
| 0 | - | General                |
| 1 | - | Plans                  |
| 2 | - | Elevations             |
| 3 | - | Sections               |
| 4 | - | Large Scale Views      |
| 5 | - | Details                |
| 6 | - | Schedules and Diagrams |
| 7 | - | User Defined           |
| 8 | - | User Defined           |
| 9 | - | 3D Representations     |

Title block shall be on the right side of the sheet extending the entire height of the sheet. All text in the title block can be orientated horizontally or vertically.

The title block shall include at a minimum, beginning from bottom of title block to top:

- Sheet number (minimum ½" text height)
- Sheet Title
- TAMUS Project Number (minimum 3/16" text height)
- Building Inventory Number (minimum 3/16" text height)
- Drawn by
- Checked by
- Name of Project
- Campus or Agency
- Location
- Firm name of Architect/Engineer under contract with owner and consultant if applicable
- Seals

All documents must be sealed or have the appropriate designation per respective licensing board rules.

## General Requirements

Cover sheet for the drawings shall contain

- Name of the project
- The university or agency name
- The A&M System project number
- Date
- The design team names and addresses
- Signature area for the Director of Project Delivery to sign as "Release for Proposals Authorized" and date.
- Copy of the project rendering or the campus/agency seal.

General Information Sheet shall contain

- Location Map showing contractor's route, construction limits and contractor lay down area
- Index of drawings
- Abbreviations used in the project
- Net and Gross square foot per floor with total and alternates separate
- Code, Structural, Mechanical, Plumbing and Electrical Design criteria
- Symbols and Legend unique to the project. Unused symbols shall not be included. Where symbols imply a specific data and/or telecom outlet provide a detail of the outlet.

Room numbers shall be part of the parametric data automatically assigned to objects by placement in rooms.

Detailing shall be adequate, with sufficient schedules, keys to materials, symbols and notes to clearly indicate the work required. Abbreviations shall be held to a minimum.

All schedules shall be derived from the BIM(s) by extracting parametric data associated with the objects used in the model.

All required details will be shown on the drawings, not in a separate manual.

All references to other disciplines shall indicate the appropriate sheet and detail.

Room finish, door and window schedules shall be on the drawings.

All items of mechanical and electrical equipment such as air handlers, pumps, fans, panelboards, light fixtures, etc. shall be scheduled on the drawings. Include all appropriate design and operating parameters for each unit. All of this data shall be attached to the associated objects as parametric data.

Electrical panelboard schedules shall list all unique characteristics of each panelboard

## General Requirements

including but not limited to each breaker size, the loading of each circuit, circuit number, wire size, main breaker size, bussing, interrupt rating and load summary. Schedules that list quantities of breakers without scheduling each circuit shall not be used. All of this data shall be attached to the associated objects as parametric data.

All panelboards, switchboards, transformers and other major electrical equipment shall have a unique identifier or tag. Panelboards shall use the following numbering scheme:

|   |   |   |
|---|---|---|
| x | p | n |
|---|---|---|

Where “x” is the floor number the panel is located on.

Where “p” is the panel type using “L” for low, “H” for high and “E” for emergency.

Where “n” is the panel sequence number.

Electrical oneline diagram shall show in a oneline format all medium voltage equipment including manholes, switchgear, transformers and cables. The 600 volt and below system shall be detailed to the branch circuit panelboard level. The size of all wire, conduit, breakers, starters, transformers, generators, meters and transfer switches shall be indicated. Tables may be used. The sizing of wire and conduit using only panel schedules will not be accepted.

Ground riser diagram shall show the size and interconnection of all grounding systems. In most cases ground conductors shall be sized larger than required by the National Electrical Code.

Telephone riser diagram shall show all riser cables, conduits, sleeves and line protectors in their relative relationship to the building.

Fire Alarm riser diagram shall show all equipment associated with the fire alarm system

Broadband distribution riser diagram (Cable Television) shall show all cable sizes, riser cables, amplifiers, splitters, outlets and head end equipment as may be required.

Lightning protection system drawing(s) shall show the arrangement of the lightning protection system with details for each unique connection and roof penetration. These details shall be coordinated and compatible with the roof system.

### Specification Requirement

Specifications shall include bidding and contract documents and technical specifications and the bound document will be entitled "SPECIFICATIONS."

The importance of accurate, complete and coordinated specifications is very important.



## General Requirements

Specifications shall be carefully checked to include all items pertaining to the project and to eliminate inclusion of items not incorporated into the project.

Specifications shall follow CSI Masterformat 2004 and be prepared on 8 1/2" x 11" paper with contents arranged in order indicated below.

Project A/E may use descriptive or performance type of specifications, naming three products by name, catalogue number and manufacturer which will meet the standards required. Care shall be taken not to adopt wording recommended by a single manufacturer if the wording will require unique or patented features of a product.

In the various specification sections where the specification is based around the performance of a specific product or model from a manufacturer (for example fixed seating, laboratory casework, laboratory equipment, air handlers, etc.) all other manufacturers listed as approved equals must also indicate comparable model numbers.

Details and schedules shall be shown on the drawings and not in the specifications

Specifications written "Install in accordance with the manufacturers specifications" are not an acceptable specification. Spell out the procedure to be used so that the FPC Project Inspector and the Contractor's Superintendent can ascertain from the Specifications the manner in which a product is to be used or applied without reference to numerous catalogues which may not be handily available.

Scope of work shall be accurately defined in each section; reference all allied work provided under other sections of work.

Clearly define work to be included under each applicable alternate in each section of work.

Omit duplication of specifications included under Uniform General and Supplemental Conditions or Special Conditions; in each instance, reference the applicable paragraph by number and expand or modify the requirement only as necessary to accomplish a specific purpose. (This is particularly applicable to Mechanical and Electrical sections).

Require delivery, acceptance and approval of all "Certificates of Manufacturer's Quality Control" before delivery of applicable equipment or material.

The specification cover shall contain the following information

- Title: "SPECIFICATIONS."
- Project Number (including Federal project number, if applicable)
- Name of Project.
- Name of University or Agency.

## General Requirements

- Location of Project.
- Owner: "THE TEXAS A&M UNIVERSITY SYSTEM."
- Set number.
- Firm name of A/E.
- Date (same as drawings).

The title page in the specifications shall contain the following information

- Title: "SPECIFICATION."
- Project Number (including Federal project number, if applicable).
- Name of Project.
- Name of Part of System applicable.
- Location of project.
- Members of the Board of Regents, The Texas A&M University System.
- Chancellor, The Texas A&M University System.
- President or Director of the University or Agency of the System.
- Chief Financial Officer and Treasurer.
- Director of Project Delivery.
- Date (same as shown on Specification cover sheet).
- List of Design Professionals with address, phone numbers and fax numbers.

The color coding and duplexing requirement for the specifications is as follows:

| Item | Name  | Provided By: | Paper Color  | Special Instructions  |
|------|---|--------------|--------------|---|
| 1    | Cover   | A/E          | A/E's Choice | One-sided, cover stock. Back cover same material and color. |
| 2    | Board of Regents Title Page                             | FPC          | White        | One-sided.  |
| 3    | Design Team Professional Seals Page:                    | A/E          | White        | One-sided.  |
| 4    | Table of Contents                                       | A/E          | White        | Two-sided.  |
| 5    | Schedule of Drawings                                    | A/E          | White        | Two-sided.  |
| 6    | Request for Competitive Sealed Proposal (CSP ONLY)      | FPC          | White        | Two-sided.  |
| 7    | Instructions for Competitive Sealed Proposal (CSP ONLY) | FPC          | Pink         | Two-sided.  |
| 8    | Supplemental  | FPC          | Pink         | Two-sided.  |

## General Requirements

|    |   |           |        |   |
|----|---|-----------|--------|---|
|    | Instructions for Competitive Sealed Proposal (CSP ONLY) |           |        |   |
| 9  | Bid/Proposal Bond (CSP ONLY)                            | FPC       | White  | One-sided. Provide two loose copies of this with proposal package to each General Contractor for bidding purposes.        |
| 10 | Part 1, Competitive Sealed Proposal (CSP ONLY)          | FPC       | White  | One-sided. Provide two loose copies of Parts 1 with proposal package to each General Contractor for bidding purposes.     |
| 11 | Parts 2 and 3, Competitive Sealed Proposal (CSP ONLY)   | FPC       | White  | One-sided. Provide one loose copy of Parts 2 and 3 with proposal package to each General Contractor for bidding purposes. |
| 12 | GMP Proposal (CMAR & DB ONLY)                           | CMAR/DB   | White  | One Sided   |
| 13 | Contract Form (CSP ONLY)                                | FPC       | White  | One-sided.  |
| 14 | Performance Bond  | FPC       | White  | One-sided.  |
| 15 | Payment Bond  | FPC       | White  | One-sided.  |
| 16 | Uniform General & Supplemental Conditions               | FPC       | Yellow | Two-sided.  |
| 17 | Special Conditions:                                     | FPC       | White  | Two-sided.  |
| 18 | Prevailing Wage Rate Schedule                           | FPC       | White  | Two-sided.  |
| 19 | Geotechnical Investigation Report                       | A/E       | White  | As received from Geotechnical Firm  |
| 20 | Division 1 General Requirements                         | FPC & A/E | White  | Two-sided.  |
| 21 | Divisions 2 through 14                                  | A/E       | White  | Two-sided.  |
| 22 | Divisions 21 through 23                                 | A/E       | Green  | Two-sided.  |
| 23 | Divisions 25 through 28                                 | A/E       | Blue   | Two-sided.  |
| 24 | Divisions 31 through 34                                 | A/E       | White  | Two-sided.  |

## General Requirements

### Request for Bid Proposal (CSP Only)

The Request for Bid Proposal will be prepared by the FPC Project Manager and issued to newspapers for publication by the Director of Project Delivery.

A copy of the Request for Bid Proposal as issued for publication will be furnished to the Project A/E for his inclusion in the Specifications. The Project A/E is to insert the advertisement as is, do not reformat.

The Project A/E shall provide a brief description of the Project and final list of alternates to the FPC Project Manager for use in preparing the Request for Bid Proposal and proposal documents:

### Federal General Requirements

One copy of each form required by the Federal Agency concerned (General requirements, wage rates, certificates, etc.) shall be bound into the Specifications on Projects involving Federal funds.

FPC Project Manager will furnish one copy to the Project A/E for his use in reproducing necessary copies.

### Alternates (CSP Only)

Provide a description of each Alternate.

Additive alternates are required for projects not involving Federal funds. For Federally funded projects deductive alternates are generally required and must be listed in order of acceptance.

### Unit Prices (CSP Only)

Used for added depth of piers and pier casing only

Provide for cost separations of items, units, etc. as directed by the FPC Project Manager.

### Addenda

Addenda shall be reserved for items inadvertently omitted from bidding documents. Documents shall be prepared in a comprehensive and a complete manner without use of Addenda.

Addenda sheets shall be 8-1/2" x 11", or the same size as those of the bid set drawings,

## General Requirements

numbered in sequence with the prefix "AD" and the date of issue and other required identification of the project.

### Printing and Binding Requirements

All drawing review sets shall be securely bound using staples or screw post. All reports required for reviews shall be bound with spiral binding or in a 3-ring binder.

All bid set drawings shall be securely bound using staples or screw post. All bid set specifications, except for 10 copies, shall be securely bound using long staples, "VELO" plastic strip, or screw posts and securely taped (ring, spiral or GBC bindings are not acceptable).

The 10 unbound sets of Specifications will be used as the actual contract documents and shall be delivered to the FPC Project Manager. **These ten sets shall not be punched or bound in any manner of fashion.**

### Electronic Drawing Files

Digital files shall follow a layer/level format that complies with the AIA CAD Layer Guidelines. The A/E shall provide a hard copy listing of all files, levels, reference file, etc. All items in digital files shall be drawn to full scale.

BIM files shall be divided by discipline/trade. Splitting models not allowable except when approved in writing by the FPC project manager. When drawings need to be split that split shall be vertically not horizontally.

Object libraries for all models shall be included with the model files. This is especially important for IFC files.

BIM files shall be provided in their native format as well as IFC. The IFC files shall be optimized prior to submission. Model files shall be named in the following format:

A B - C E F G H I J K L M N O P Q R S . T U V

- A-B - Campus Number
- C-G - Project Number
- H-K - Building Number (if required)
- L-O - Abbreviated Project Name (add more letters if needed)
- P-S - Discipline (Arch, Elec, Mech, etc)
- T-V - File Extension

In cases where there are more than one building involved in the project the building number shall be used after the project number to differentiate between the two.

## General Requirements

During the course of the design digital files are required by FPC Interior Designer for furnishings layouts and by Project Controls Division to update campus maps for illustration purposes. These digital files shall be made available to FPC Project Manager (two weeks before each meeting) at the following project milestones:

1. Design Development (architectural floor plans & site plan)
2. 50% Design (architectural floor plans only)
3. 75% Design (architectural floor plans only)
4. 100% Design (architectural floor plans & site plan)

### Electronic File Names

DWG and PDF files will be required for all sheets in the drawing sets. The file names used for all digital files delivered to Facilities Planning and Construction shall follow the following format.

A B C D E - F G H I J K L M N O P Q . R S T

A-C - Sheet Number (This refers to the overall number in the set)  
D-E - Campus Number  
F-I - Project Number  
J-M - Sheet Number  
N-Q - Sheet Name  
R-T - File Extension

### Electronic Folder Names

An electronic folder structure has been established by FPC. This structure along with example file names shall be provided by the FPC project manager.

### Record Drawings

All changes during the course of the design and construction shall be incorporated into the BIM (s). The A/E is responsible for making changes through the issue of all addenda at which point the model(s) will be turned over to FPC and the GC/CM. The A/E shall also be responsible for providing updates to the model(s) that are changed through RFI, ASI, CCD, Approved Proposal Request, The GC/CM shall be responsible for maintaining and updating the model(s) after the issue of the final addendum. The model(s) shall be maintained as the as-built model(s) from which the record drawings will be derived.

Deliver to the OWNER the original or reproducible film positive copies, corrected to be "Record Drawings" made from the contractor's "Record Prints" and one additional set of

## General Requirements

reproducible film positive copies of these drawings. Paper sepias are not acceptable. Record drawings plotted with green ink are not acceptable. All sheets from the "Bid Set" must be included in the "Record Drawing Set" and each sheet marked "Record Drawing" with date. Each sheet must be so marked regardless if there were any changes from the Contractors Record Drawing Set.

Deliver to the OWNER two (2) copies of all drawings in DWG and PDF format, native model files, as well as IFC file format, corrected to be "Record Drawings" on disk type media (DVD or CD). The disk shall be labeled with a pre-printed label that contains the name of the project the university/agency, the project number, GC/CM name, and the A/E firm name. No other digital format will be accepted. Scanning of drawings is not acceptable.

The digital version of the record drawings shall have one digital drawing file for each drawing sheet in the project bid set. All reference files and "xrefs" must be inserted into the final digital file.

### COBie Data Sets

The GC/CM is required to submit data in the most current version of COBie. Assembly of the COBie data requires that the A/E, GC/CM, and commissioning agent provide or even input data into either the BIM(s) or a MS Excel spreadsheet. The GC/CM is responsible for coordinating and compiling this data. The preferred method for assembling the data is by deriving/extracting the data from the BIM(s).

For more information on COBie refer to The Whole Building Design Guide. <http://www.wbdg.org/resources/cobie.php>

### Cost Control

In the Program of Requirements the project scope matches the "Base Bid Scope" line item on the Estimated Project Budget page. To achieve an awardable project, the base bid represents 90% of the funds available to award a construction contract. The Project A/E is required by contract to work with the Users and the Facilities Planning Division to keep the design within the "Base Bid Scope" and identify additive alternates to utilize all project funds. Deductive alternates will not be considered.

Throughout the design process, the Project A/E and Construction Manager at Risk or Design-Build Contractor will be required to furnish knowledgeable cost estimates for all items of construction. These estimates shall be itemized in sufficient detail so as to allow the University to make informed choices when questions of priority are considered to include or exclude an item. The A/E shall share the BIM(s) with the CM. The CM is encouraged to use these models for establishing conceptual pricing.

## General Requirements

### Coded Estimate System

Code A Estimate: Based on completed Program of Requirements.

Code B Estimate: Based on and submitted with completed Schematic Design (A/E, CMAR, D-B responsibility). The estimate detail shall be in Unifomat 98 (Assemblies) format.

Code C Estimate: Based on and submitted with completed Design Development (A/E, CMAR, D-B responsibility). The estimate detail shall be in Unifomat 98 (Assemblies) and Masterformat 2004 format.

Code D Estimate: Based on and submitted with completed Construction Documents (A/E, CMAR, D-B responsibility). The estimate detail shall be in Masterformat 2004 format.

Code E Estimate: Submitted 10 days prior to Bid Opening (CSP Only); based on changes in Construction Documents and other events that have occurred since Code D estimate was submitted. For the Code E estimate, if there is a major change in the estimate from the Code D estimate the A/E shall also provide the estimate detail in CSI Masterformat 2004, otherwise only the summary is required.

The Project A/E is cautioned not to confuse the design contingency indicated on the team's estimate with the Bid Contingency (CSP Only) indicated in the POR. These numbers are not the same. Based on the level of completeness of the design there will be a design contingency percentage that is included by estimators. This percentage will decrease as the design proceeds towards the Construction Documents review. The Bid Contingency number is only for variations in the bidding market that were not anticipated by the A/E team's estimator and to purchase additive alternates.



General Requirements

Cost Estimate Format

(THE ARCHITECT/ENGINEER WILL NOTE THAT THE CONSTRUCTION COST IS ONLY A PART OF THE PROJECT COST. THE A/E SHALL SUBMIT COST ESTIMATE IN THIS FORMAT ONLY. USE ONLY ITEMS APPLICABLE TO THE PARTICULAR PROJECT. DO NOT USE "N/A." CHANGE NUMBER SEQUENCE IF A CERTAIN LINE ITEM IS OMITTED.)

(Project Name) Project No.
(System Member) Date
(City)

CODE "\_\_\_" COST ESTIMATE

Total Gross Building Area: s.f.
Total Site Acreage: ac.
Total On-Site Parking Spaces:

(ITEM NUMBERS 1, 2, AND 3 BELOW INCLUDE GENERAL CONDITIONS, OVERHEAD, PROFIT AND BONDS.)

- 1. Building Cost
a. General Construction--Building excavation, foundation, structure, roofing, exterior and interior walls, doors, windows, finishes, specialties, and conveying equipment except as listed below \$ xx,xxx.00
b. Plumbing--All building plumbing to five (5) feet outside of building line xx,xxx.00
c. Mechanical--All building HVAC, including heating and chilled water lines, to five (5) feet outside of building line xx,xxx.00
d. Electrical--All building electrical work to five (5) feet outside of building line xx,xxx.00
e. Total Building Cost \$ xxx,xxx.00
2. Fixed Equipment Cost
a. Built-in lockers, food service, fixed seating, casework, fume hoods, etc. xxx,xxx.00
3. Site Development Cost

## General Requirements

|    |   |                      |
|----|---|----------------------|
| a. | Demolition--All demolition; whether site, structures, mechanical, electrical or plumbing, excluding asbestos removal                    | \$ xxx,xxx.00        |
| b. | Site Development--All walks, drives, parking, grading, walls, steps, and site appurtenances from five (5) feet outside edge of building | xxx,xxx.00           |
| c. | Landscaping--All trees, shrubs, sod, planting and irrigation  | xxx,xxx.00           |
| d. | Site Mechanical--All HVAC and plumbing lines from five (5) feet outside edge of building, including storm and sanitary sewer systems    | xxx,xxx.00           |
| e. | Site Electrical--All electrical work from five (5) feet outside edge of building and cost of transformers regardless of location        | xxx,xxx.00           |
| f. | Total Site Development  | \$ <u>xxx,xxx.00</u> |
| 4. | <b>ESTIMATED CONSTRUCTION CONTRACT AMOUNT (SUM OF 1, 2, AND 3, Not to exceed 90% of Line 6)</b>   | x,xxx,xxx.00         |
| 5. | Bid Contingency (CSP)   | xxx,xxx.00           |
| 6. | <b>AMOUNT AVAILABLE FOR CONSTRUCTION CONTRACT</b>   | \$ x,xxx,xxx.00      |

Building Unit Cost (ITEM 1.e "TOTAL BUILDING COST" DIVIDED BY TOTAL GROSS SQUARE FEET) ..... \$xx.xx Cost/G.S.F.

Alternates (CSP ONLY - LIST BY NUMBER WITH BRIEF DESCRIPTION AND ESTIMATED COST)