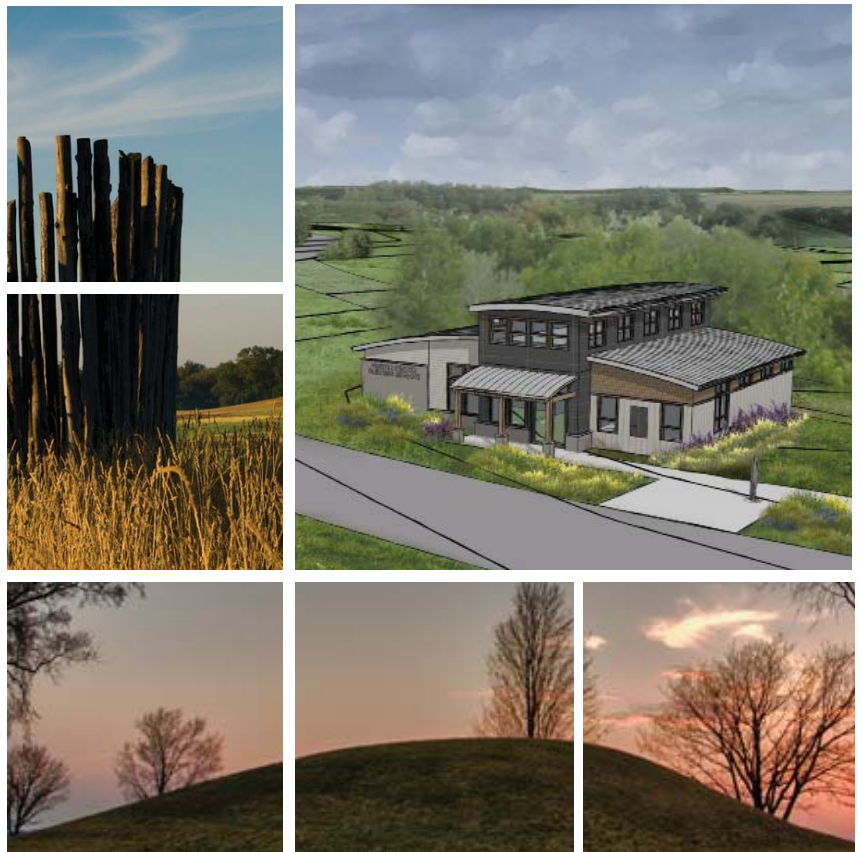




## Design Report Appendix

### Friends of Aztalan State Park Visitor Center

Aztalan, Wisconsin  
June 15, 2015



Photography by: Daniel Seurer

**DIMENSION**   
— Madison Design Group

architecture • interior design • planning

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## Project Team

<b>Owner</b>	Friends of Aztalan State Park PO Box 855 Lake Mills, WI 53551
<b>Architect:</b>	Dimension IV Madison Design Group 6515 Grand Teton Plaza, Suite 120 Madison, WI 53719
<b>Civil, Structural and Mechanical Engineering:</b>	Oneida Total Integrated Enterprises (OTIE) 5100 Eastpark Boulevard, Suite 300 Madison, WI, 53718
<b>Electrical Engineering:</b>	Hein Engineering Group 319 West Beltline Highway Suite 111 Madison, WI 53713
<b>Landscape Design:</b>	Kate Stalker Associates Madison, WI



## **Design & Planning Issues**

### **1) Site Conditions**

Aztalan State park has been managed by the Wisconsin Department of Natural Resources since 2000 and is currently 172 acres. The park contains numerous archaeological features from the Middle Mississippian and Woodlands Native American cultures in addition to the park offers compatible modern-day recreational opportunities. The site has been designated as a National Landmark, is listed on the National Register of Historic Places and is a human burial site.

As identified in the park master plan, as adopted in June, 2003, the new Visitor Center will be located on approximately 2.3 acres of land on the current western edge of the park. This area has been previously disturbed and extensively sampled with test pits by prior archeological surveys and is believed to be “clean” of artifacts. By developing this area of the park, the Visitor Center will not obstruct the existing views from within the site, especially from atop the mounds. The location is however very visible from Highway Q and the Visitor Center will be a prominent feature when first entering the park.

The proposed site presents some constraints in the placement of the building. The building has been sited between the current park drive and the proposed re-routed location, there is also a setback requirement from County Highway Q. In addition to the constraints of the roads, there are several large mature trees that are to be preserved. Great care is required to minimize disturbance to the trees with regard to grading the surrounding area and primary construction activities. A topographical survey of the area immediately surrounding the new building site has been accomplished.

### **2) Zoning**

The park currently falls under Jefferson County's A-1 Exclusive Agricultural zoning ordinance. A formal variant may be required, including public hearings and final approval by the Jefferson County Planning and Zoning Committee.

### **3) Utility Service**

There is no existing natural gas service to this area of the park. WE Energy has indicated that extending the existing main from the Town of Aztalan would be an expensive and un-economical endeavor. Therefore, if needed for mechanical systems, an onsite propane tank would be required.

Water will be provided by an on-site domestic water well. A septic system will be utilized; a drain field system is preferable as a mound system could be perceived as having archaeological significance. Preliminary soil conditions seem suitable for a drainage field to the north although a percolation test to confirm these assumptions is pending.

WE Energies will extend a 1-phase power line to the site along highway Q with a pole-mounted transformer and underground service to the building.

### **4) Historic Preservation**

The entire site had been designated as a National Landmark, and is listed on the National Register of Historic Places. The site falls under both Wisconsin State Statutes 44.40 – Historic Field Archaeological Act and 157.70 Burial Site Act. Therefore the design is to be reviewed by the State Historical Society and supervision by an archaeologist during excavation activities will be required.

### **5) Environmental Impact**

The Wisconsin Department of Natural Resources has classified this as a Type \_\_\_\_\_ project requiring . . .

## **6) Other Legal/Regulatory Issues**

The new Visitor Center is a project undertaken by and funded by the 501c3 private, non-profit Friends of Aztalan State Park ("Friends"). Once construction has been completed and the new Visitor Center occupied, the Friends will gift the building to the State of Wisconsin via acceptance by the Natural Resources Board. As a result, DOA/DFD standards must be met in the design and construction of the facility. As part of this on-going effort representatives of the WDNR have been involved in the preliminary design.

## **7) Schedule Issues**

The Friends' group is in the midst of a capital campaign to generate funds for the cost of design and construction of the new facility. As part of this effort a Construction Manager (Maas Bros Construction, Watertown WI) has been contracted to perform tasks such as project cost estimating and eliciting competitive bids to ensure a successful, budget conscious project. Until their funding goals are met, no further design or production of construction documents will proceed.

In addition to the funding restraints, it may be advantageous for construction to be scheduled to begin late summer- early fall. At a modest premium, construction could continue through winter, and would allow for occupancy of the building to be ready at the start of the visitor season. Furthermore the bulk of construction would happen outside the park's peak visitor season and therefore minimize the disruption to the visitor experience.

The proposed road work, as indicated in the park's master plan, to divert the current park drive around the Visitor Center to the west would also complicate construction scheduling. Although the design would allow for the current road to remain for some time, it would be best for park operations if both projects could happen concurrently. This would minimize the cost of land rehabilitation and landscaping.

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### Space Tabulation

The following is a tabulation of net area and occupant load of each space in the proposed Visitor Center:

Room Name	Net Square Feet	Occupant Load
Lobby/Exhibit	790	48
Multi-purpose Room	990	142
DNR Work Area	185	3
Friends' Shop (Display)	260	9
Net Assignable (ASF)	2225	
Table/Chair storage	270	1
Public Restrooms	290	
Utility Room	120	1
		Total: 197
Gross SF (GSF)	3155	
Agency Method (ASF/GSF):	70%	
BOMA ((Usable+Common Area)/GSF)	96%	

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### **Site Program**

- 1) Zoning Ordinance
  - Zoned A-1 Exclusive Agricultural
  - Height: 35 feet maximum.
  - Front Setbacks: 85' from centerline; 50' from right of way.
- 2) Traffic/Parking/Pedestrian Access
  - Bicycle parking.
  - Barrier free accessibility.
- 3) Storm Water
  - Sediment control for water quality from paved area run off.
  - Capture "clean" roof water for irrigation (internal vault).
  - Pervious surfaces at outdoor terrace.
- 4) Services
  - Trash.
  - Electrical transformer and Air conditioning condensers.
  - Domestic water wellhead.
  - Septic tank and drainfield with vent pipes.
- 5) Landscaping
  - Inviting entry plaza.
  - Simple and durable plantings (trees, shrubs, grasses and seasonal planting areas).
  - Landscape buffers.
- 6) Lighting
  - Building entrance and security lighting.
  - Non-glare fixtures, down-lighting only.
- 7) Miscellaneous Amenities
  - On-building sign facing Highway Q.
  - Donor features (flagpole, benches or pavers).

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AREA:	<b>LOBBY/EXHIBIT</b>
SIZE:	790 square feet.
FUNCTION:	Main access to library and Multi-purpose/Community Room Display and distribution area for information of interest to the public Access to public restrooms and drinking fountain Serves as a pre-function and break-out space for the Multi-purpose/Community Room Access to Janitor's closet Possible access to a Friends store
FINISHES:	Floor: Polished/Stained Concrete Walls: Painted Gypsum Wallboard Ceiling: Wood T&G Paneling
SPECIAL REQUIREMENTS:	Double set of entry doors for delivery access. Doors should be accessible for patrons with strollers and individuals with handicaps automatic entry doors. Made of safety glass and metal frame Visitor Center can be closed, but access to lobby and community room can still be available. Electronic security control Provide a well-lit (overhead) area for patrons waiting for a ride
FURNISHINGS:	Electric water coolers: 1 pair at two heights as required by Code. Wall mounted bulletin board and racks for brochures and other literature. Display case: One wall mount and one floor (existing) Donor wall feature – recognition plaques and/ or floor tiles Sign: hours of service. Seating/ Bench Waste/recycling receptacles
COMMENT:	

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AREA:	<b>MULTI-PURPOSE ROOM</b>
SIZE:	990 square feet (142 Occupants @ 7 SF/person)
FUNCTION:	Provides an area for meetings for community organizations Provide space for the public to rent Provide a gallery space Storage room for nesting tables/chairs, etc. Provides storage for service clubs/ group to use
FINISHES:	Floor: Polished/Stained Concrete Walls: Painted Gypsum Wallboard Ceiling: Suspended ACT
SPECIAL REQUIREMENTS:	The meeting room should have easy access to parking, restrooms and kitchenette. Accessible during non-business hours Separate thermostat control from Visitor Center Future Movable wall partition should be installed to partition the room in to two areas 60% and 40%, with separate lockable entrances. Movable partition to have a high sound rating and sound seals. Space should be easily reconfigured Special attention should be made to acoustics/ soundproofing Dimmer switch for lights and light controls to permit a variety of lighting levels.
FURNISHINGS:	Chairs for 100 Tables to seat 8                      12 tables total Coat storage              Coat hooks/ racks Storage 270 square feet (100 chairs with dollies and tables) Lockable AV cabinet Ceiling-mounted LCD projector White wallboard suitable for projection with tray Sound system for microphones and audio equipment Room-darkening shades Tackable surface Podium Wall art hanging system

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AREA cont.

### **MULTI-PURPOSE ROOM**

#### COMMENT:

To have a meeting room that seats 100 in chairs (142 occupancy capacity), plus area for presenter.

Wired for future wireless routers. Multiple outlets on all walls for use of various AV equipment including some floor outlets.

Area near kitchenette should have multiple outlets at table height (crockpots, etc.) for event use.

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AREA:	<b>STAFF WORK AREA</b>
SIZE:	185 square feet
FUNCTION:	Accommodate staff workspace for tasks Workspace for at least two adult staff members (part-time) Storage of small and large supplies
FINISHES:	Floor: Commercial Grade Carpet Tile Walls: Painted Gypsum Wallboard Ceiling: Suspended ACT
SPECIAL REQUIREMENTS:	(2) Two staff workstations per DNR standards including computers, printers, wiring, etc. Adjustable shelving storage for office supplies Space of staff members to store projects Extra outlets Paper cutter, wastebaskets, recycling tubs, clock Through-wall deposit box (Self-registration for Park Pass)
FURNISHINGS:	Computer work stations per DNR standards Cabinets and drawer space for storage 84" high shelves for storage of books and supplies Table for project workspace Bulletin board
COMMENT:	Space designed to facilitate a smooth workflow



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AREA:	<b>FRIENDS' SHOP (DISPLAY AREA)</b>
SIZE:	260 square feet.
FUNCTION:	Sale of used library materials, donated books and possibly small gift items Open limited hours – Weekends based on volunteer availability Near Entry
FINISHES:	Floor: Commercial Grade Carpet Tile Walls: Painted Gypsum Wallboard Ceiling: Suspended ACT
SPECIAL REQUIREMENTS:	Shelving and display units for visitor browsing. Bulletin board or tackable surface for pricing, Friends' events, etc.
FURNISHINGS:	Plastic-Laminate display shelving units
COMMENTS:	Additional storage space for merchandise within Storage Room

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AREA:	<b>PUBLIC RESTROOMS</b>
SIZE:	290 square feet
FUNCTION:	Provide male and female toilet facilities.
FINISHES:	Floor: Ceramic Tile Walls: Ceramic Tile / Painted Gypsum Wallboard Ceiling: Gypsum
SPECIAL REQUIREMENTS:	Should be located near the Lobby and Multi-purpose/Community Room. ADA compliant stall and clearances throughout Ceramic tile should be used on floors and half-way walls behind and adjacent to fixtures. Easy open doors with kick plates and push plates. Lockable doors for after-hours access control. Consider automatic sensor on lights Ventilated with exhaust fans
FURNISHINGS:	Toilets (3 toilets and 2 lavatories in women's; 1 toilet, 2 urinals, 2 lavatories in men's) Wall –mounted sinks Liquid soap dispensers Mirrors with shelf below Automatic hand dryers Double toilet-paper dispensers Sanitary napkin dispenser Trash containers near sink Fold-down changing table in both women's and men's Automatic sensor on urinals and sink faucets Floor drain in all restrooms Solid surface, vandal-resistant toilet partitions
COMMENT:	Surfaces and fixtures should be designed to deter vandalism and with have ease of cleaning/ maintaining

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AREA:	<b>UTILITY/JANITOR ROOM</b>
SIZE:	Per layout, included in unassigned space
FUNCTION:	HVAC equipment for Offices, Restrooms and Lobby; water service entrance; electrical service entrance, water heaters and water softeners. Provides storage for interior maintenance and cleaning supplies, light bulbs, paper products.
FINISHES:	Floor: Sealed/Stained Concrete w/condensate drains Walls: Painted Gypsum Wallboard Ceiling: Suspended ACT
SPECIAL REQUIREMENTS:	Requirements and clearances per specific mechanical and electrical equipment. Space clearances and access per equipment requirements such as coil replacement at air-handling units. Exterior exhaust and intake
FURNISHINGS:	Heavy duty wall-mount shelving Floor-mounted mop sink with hose Recyclables storage Floor drain near sink area
COMMENT:	Input from custodian (whoever is contracted to clean) is recommended

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AREA:	<b>Table/Chair Storage</b>
SIZE:	Per layout, included in unassigned space
FUNCTION:	HVAC equipment and electrical panel for multi-purpose room and gift shop; Provides storage for tables and chairs for use in the multi-purpose room.
FINISHES:	Floor: Sealed/Stained Concrete w/condensate drains Walls: Painted Gypsum Wallboard Ceiling: Suspended ACT
SPECIAL REQUIREMENTS:	Requirements and clearances per specific mechanical and electrical equipment. Space clearances and access per equipment requirements such as coil replacement at air-handling units. Exterior exhaust and intake
FURNISHINGS:	Clear floor space markings around all mechanical and electrical equipment.
COMMENT:	

## **Design Concept**

### **1) Overall Architectural Design Concept**

The Visitor Center is located on the western perimeter of the site just off of HWY Q. It is sited to the west of the existing park road but primarily designed to accommodate the future relocated park drive as shown in the 2003 Park Master Plan. The relocated road is itself outside of the scope of work for the Visitor Center although work may be done concurrently.

The design of the Visitor Center is respectful and subordinate to the site as a whole and is meant to recede into the background of the landscape. An underlying goal of the project was for the sightlines from atop the historic mounds to remain unimpeded. The location of the building on the site aids in this, as it is largely shielded by existing mature trees and topographic features. The building utilizes a muted exterior color palette to further blend into the landscape.

The structure is conceptually divided into three joined rectangular volumes. The volumes are shifted in plan creating not only a pronounced entry central entry, but also act to define an exterior southern exposed patio space to the west of the building. The building has gently sloping curved roofs with the central volume having additional height. This gives the overall structure a gestural form reminiscent of a platform mound. The building is axially oriented toward the southern mound and stockade. In this manner visitors will be able to orient themselves between the exhibits and the park as a whole.

The proposed Visitor Center is intended to primarily serve the general public as an informational center and enhance the overall experience for visitors to the state park. The Visitor Center will orient visitors to the historic site in a contemporary context. The building contains, exhibit space, a large multi-purpose room, gift shop - operated by the Friends of Aztalan State Park, and modern restroom facilities. The building will also serve as an office for the DNR park manager, although the building itself may not be staffed full time.

The main entry to the Visitor Center will be from the west, this will aid in visitor wayfinding as it is visible not only from the county highway and the parking lot. The building exterior will include a covered canopy and exterior park information with drop-box for purchase of state parks permits.

The lobby and exhibit space will occupy the center of the building. Regional and park information will be distributed from kiosks within the lobby and feature a reception desk for use by both the DNR and gift shop staff. Long-term exhibits showcasing the archaeological significance of the park will be the main function of the space. The design of said exhibits is outside the scope of the project, but accommodations for required electrical service and data ports have been made. The space will feature large windows directing views towards the southern mound, it will also have clerestory windows for additional natural daylighting along the north and south walls. Other spaces are accessed directly off of the lobby minimizing square footage lost to hallways.

The multi-purpose room will have views of the park to the north, east and south. It will be able to accommodate 140+ visitors for lectures, and approximately 60 visitors for events utilizing tables and chairs. The space will also be divisible through the use of a movable wall partition. The room will have base cabinets along the north wall. This provides ample storage and will be suitable as a field lab during archaeological digs. The eastern side, with direct access to the exterior, will also contain a sink. It will be fitted with a plaster trap, as it is expected to be used by the archaeologists to clean artifacts. An adjoining storage/utility room provides ample storage for the tables and chairs.

The gift shop is to be operated by the Friends of Aztalan State Park. It will likely be open only during the peak season, and rely on volunteer availability to maintain semi-regular hours. It is significantly larger than required for display of the current range of souvenir and books offered by the Friends group. With the additional space it is anticipated that the group will expand their inventory and also offer refreshments and other visitor necessities such as bug spray and sunscreen. The group will share use of the front reception desk with WDNR. A point of sale system, allowing for separate use by each organization, would be utilized.

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The Wisconsin Department of Natural Resources will have a small office within the building for two workstations and minimal storage. It will be used by the park manager and Glacial Drumlin Trail manager. It is anticipated that once the new building is occupied, the WDNR will vacate the current office space in the Lake Mills Depot.

The restrooms provide visitors modern facilities, with low flow fixtures and baby changing stations. Additional fixtures beyond code minimum have been provided to efficiently accommodate large school groups or special outdoor events that would attract additional visitors to the park.

### 2) Site Design

The approach to the Visitor Center is punctuated by groupings of native shrubs, which cross the road to give the visitor the sense that the naturalized plantings preceded the construction of the entry drive. A monument sign signifies that the facility is near, a subliminal cue to slow the vehicle and watch for pedestrians. Next to the monument sign is a bio-infiltration basin, which is the release point for the facility's internal cistern.

The parking area, opposite the Visitor Center to the right, is a 2-way, 90° parking area. It is screened from the highway with existing mature trees as well as saplings and native shrubs. Between its east side and the entry drive lies a bio-infiltration and conveyance swale. At the south end, the existing asphalt path is extended to reach the facility.

Along the entry drive are 2 handicap stalls. One is van accessible and ADA compliant sidewalks lead to the main entrance of the Visitor Center. There is ample room for loading and unloading a full-size school bus between these stalls and the front door. For visitors waiting for pick-up, two benches are provided outside the main entry, sitting next to potted annual flowers to create a welcoming atmosphere.

The Visitor Center itself is tucked into the existing grove of trees to screen it from the park attractions. We have delineated the drip line of these existing trees plus 5', to fence prior to and for the duration of construction, so that their health may be preserved. From the interior of the facility, views toward the park stockade are unobstructed under the canopy. Exiting the rear of the facility, a paved path leads the visitor through a series of spaces, and benches line the path to provide respite. Ten by twelve foot picnic areas are displaced from the path by narrow walks and plantings of native shrubs for privacy. Each area can accommodate a wheelchair. The main gathering area has two rows of naturalized 'bleachers', a large paved center and a framed lawn space for expansion. In keeping with the history of Aztalan, the backdrop of this area is a miniature stockade in the style of its earliest designers, a clear distinction from the Visitor Center and creating a transition to the historic areas of the park. It serves as an outdoor classroom and a space for fundraisers, speakers, and private rentals. Young trees will be planted within the right-of-way of the existing drive, and groupings of native shrubs will work to separate uses, screen structures & furnishings, and frame spaces.

This site work is phased in three distinct areas of work due to the demolition required to complete the project, but it is assumed that all work take place consecutively without intermission until the exterior gathering spaces are installed and screened.

There will be a limited amount of grading related to the proposed building foundation, and some minor grading to allow for a level outdoor patio area, adjacent to the building, on the site. It will be very important to save several larger diameter existing trees, near the proposed building location. Tree protection will be an important part of this project.

Erosion Control measures meeting the Wisconsin DNR Technical Standards will be provided to mitigate the impact to the surrounding areas during construction. These best practices will included: a stone tracking pad, silt fence and/or silt socks, minimizing the amount time the site is disturbed, and the appropriate landscaping & vegetation, used to stabilize the disturbed areas.

Stormwater management measures, again meeting the WI DNR Technical Standards, for the project will include some type of storage tank for a portion of the roof water runoff. This water could be reused for watering plants on the site. The portion of the roof that does not go to the storage tank could go to an infiltration swale along the side of the building. The outdoor patio area could be built with pervious paving, again to maximize the amount of stormwater runoff from the project that infiltrates back into the ground.

The design team will work with the DNR on these and other possible Stormwater Management & Erosion Control (SWM & EC) measures, as part of the Wisconsin DNR WRAPP/NOI submittal and review process.

### 3) Architectural Systems

The proposed Visitor Center is a wood framed structure on a traditional slab on grade with foundation walls and footings. The exterior will have a stone veneer base and fiber cement panels and lap siding above. Exterior walls feature an air-vapor barrier and minimum of 1" continuous insulation in addition to stud cavities being filled with R-19 batt insulation. Exterior doors will be insulated hollow metal with tempered full glass lites. Windows are metal clad wood frame with Low-E triple pane glazing. Operable awning windows are provided in the main lobby and Multi-purpose room to allow for natural ventilation. The central lobby space will have raised ceilings with exposed glulam beams/trusses. The lobby roof will have continuous insulation entirely above the roof deck with a minimum R-value of 30. The north and south wings having conventional trusses – all will have standing seam metal roofs as the low pitch of the roof is unsuitable for shingles. A minimum of R-50 blown cellulose insulation will be provided in the attic spaces above the north and south wings.

Interior walls will be of wood stud construction with abuse resistant gypsum wall board in all public locations extending to 8'-0" min above the floor. Flooring will be no-wax polished concrete, requiring minimal ongoing maintenance through the lobby, multi-purpose room, and utility rooms. The gift shop and DNR office will receive heavy commercial grade carpet tile. The toilet rooms will receive ceramic tile floors and walls, as well as vandal resistant, solid surface toilet partitions for easy cleaning. Each restroom and utility space will receive floor drains.

Interior doors will typically be a solid core, wood veneer in metal frame. The gift shop will receive a 16' wide rolling security grille. The moveable wall partition in the multipurpose room is to be of durable material with high acoustical performance values. Select doors including the main entry, and multi-purpose room doors are to receive electric access controls for programmable access during and after typical business hours.

### 4) Plumbing and Fire Protection

The water service to the building shall be provided by a well dedicated to the facility. The water supply to the building shall be treated by a water softener. Hot water shall be provided by electric water heaters. A tank style electric water heater shall serve the hot water needs of the toilet room group and utility room, and a tank-less type electric water heater shall serve the hot water needs of the sink located in the multi-purpose room. Plumbing fixtures (toilets, lavatories, urinals) shall be low-flow style fixtures constructed of vitreous china. Toilets and urinals shall be wall hung style and waste piping shall be routed through a carrier system above grade in plumbing chase. Water supply piping shall be copper, waste piping shall be ductile iron, and vent piping shall be PVC. PEX piping shall be used where water supply piping needs to be routed underground to accommodate remote plumbing fixture location from the main water service piping. The sink located in the multipurpose room shall be equipped with a sand / plaster trap on the waste piping.

The building does not require an automatic fire sprinkler system by code.

### 5) Heating, Ventilation and air conditioning

The HVAC systems shall consist of standard efficiency commercial grade / sized gas-fired furnaces configured to operate using liquefied petroleum gas (LPG) for heating. Cooling shall be provided by air cooled condensing

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units located outside the building with refrigerant piping routed into the building and connected to DX cooling coils located at the furnaces. Furnace units shall be provided with dual-circuited DX cooling coils to allow for staging of cooling equipment and a dehumidification mode operation.

The required outside air for ventilation shall be routed through plate and frame air to air heat exchangers used as building exhaust fans to reduce the affect that outside air used for ventilation has on the heating and cooling load requirements of the building. Air shall be distributed throughout the facility through insulated (wrapped) sheet metal supply and return ductwork and metal supply air grilles / diffusers. Air filtration shall be provided at the air handling units by disposable 2" thick MERV 8 rated filters. The air handling units shall be provided with 100% outside air economizer functions and controls, (including motorized dampers, outside air enthalpy economizer control) return duct mounted duct smoke detectors, and overall system operation shall be controlled by a basic building –wide electronic / DDC automatic temperature controls system.

The high ceiling lobby / exhibit space shall be served by ceiling mounted de-stratification fans to eliminate heated air being trapped in the high ceiling portion of the facility.

Spot heating shall be provided near exterior doors and in the toilet rooms with electric heaters, either fan forced or convection style.

### Geothermal Heat-Pump System (Alternate Bid):

Geothermal Field: Shall consist of vertically bored wells (approximately 300 feet deep) arranged with a minimum 20 foot spacing between wells as indicated on the Mechanical Site Plan. Well piping shall be HDPE (high-density polyethylene). Geothermal field piping system shall contain a solution of water and glycol to prevent against freezing of fluid solution at exterior winter outside air design temperatures.

Geothermal wells shall be served by pumps to circulate glycol solution between heat pumps located inside the building and the wells that make up the geothermal field.

Interior building heat pumps shall be high efficiency two stage model with fans, filters, electrical disconnect switches, and integral compressors.

## 6) Electrical

WE Energies will extend a 1-phase power line to the site along highway Q with a pole-mounted transformer and underground service to the building.

The electrical system will be provided to a 300-amp, 1-phase 120/240 volt pedestal meter with manual transfer switch for portable generator connection. The main distribution panel A will be provided with a 400-amp main circuit breaker and surge protection device (SPD). A sub-panel B will be provided to service the south side of the building.

Power distribution to motors and equipment will be provided from Panel A on the north side and Panel B on the south side. Flush floor boxes with hinged covers and recessed activated devices will be provided in the Lobby/Exhibit area and Gift Shop.

Interior lighting will consist of high-efficiency LED systems with dimming drivers where shown on the drawings. The Lobby/Exhibit space will be provided with a cable supported track lighting system for flexible lighting of displays and exhibits along with pendant downlighting at the ceiling for general illumination. Office and Multipurpose rooms will employ troffer LED lighting with dimming controls. Spaces with intermittent occupancy will be equipped with occupancy sensors. Exterior lighting systems will consist of bollards along the walkways and a pole-mounted fixture at parking area with LED lamping and cutoff illumination for dark sky compliance. All



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exterior lighting will be controlled by photocell on and off in conjunction with time clock overrides. Exit and emergency egress lighting will be provided with battery back-up.

Voice/data outlets will be provided with raceways to accessible ceiling spaces cabling or piped directly to the communication wiring cabinet in the Table/Chair Storage. The wiring cabinet will consist of a wall-hung hinged data rack and voice terminations will be provided on a plywood backboard with grounding buss. All telecommunication drops will be provided per DSF standards.

## **Sustainable Design**

In addition to the Wisconsin DOA, DFD sustainability standards, LEED NC-2009 benchmark standards will be followed for the design and construction of this project. This will ensure that the project will be environmentally responsible and minimize the long-term costs of operating the building as well as provide a healthy, pleasing and efficient building for the occupants and users. The following sustainable strategies (**In bold**) will be incorporated into the project final design and construction documents, and if all of these strategies are successfully implemented the project would qualify to become LEED Silver. The Sustainable Facilities Standards Checklist and proposed LEED NC-2009 checklist of the sustainable goals follows the descriptions below. Non-applicable credits are noted with a brief explanation.

### Sustainable Sites

- SS.** A soil erosion, waterway sedimentation and dust control plan will be required during construction to minimize erosion, soil loss and pollution during construction.
- SS1. The site selected is a previously undeveloped site that is not prime farmland, parkland, habitat to endangered species, a wetland or within a flood plain. (Regional priority credit.)
- SS2. Development density and community connectivity – N/A.
- SS3. Brownfield redevelopment – N/A.
- SS4.1 Alternative transportation – public transportation access – N/A; There is currently no public transportation available in the area.
- SS4.2 Alternative transportation – Bicycle storage for 5% of building users and changing and shower facilities for employees. (Regional priority credit.) – N/A; No shower facilities are currently present in the State Park and none are desired in the proposed Visitor Center.
- SS4.3** Alternative transportation – Preferred parking for low-emitting, fuel efficient vehicles; 5% of total or 4 stalls.  
N/A - Parking is beyond the proposed scope of work.
- SS4.4** Alternative transportation – Parking capacity not to exceed minimum local zoning requirements and provide preferred parking for carpools for 5% of total or 4 stalls. N/A – Parking is beyond the proposed scope of work.
- SS5.1** Site development – Protect/restore habitat and promote biodiversity. Limit site disturbances to clearly marked boundaries beyond new building and site improvement construction perimeters. Use native plantings in landscaped areas. Stack parking below upper floor and share parking with neighbors. (Regional priority credit.)
- SS5.2** Site development – Maximize open space. Provide vegetated open space equal to 20% of the project site area, which can include shallow sloped, vegetated Storm water ponds. (Regional priority credit.)
- SS6.1.** Storm water quantity control measures will include vegetated Stormwater ponds and raingardens. Some parking stacked below upper floor, overflow parking on pervious surface, and capture roof water for irrigation use. Stormwater management plan to maintain post-development discharge rate and quantity lower than pre-development rate and quantity for 1- and 2-year 24-hour design storms. (Regional priority credit.)
- SS6.2** Storm water quantity control measures will include vegetated Stormwater ponds, swales and raingardens. Due to bedrock, infiltration on this site will be minimal. Capture and treat runoff from 90% of average annual rainfall and remove 80% of solids per best management practices.
- SS7.1** Reduce heat island effect (non-roof). Shade drives, parking lots and pavements using stacked parking, shade trees, light-colored pavements and green pave parking surfaces.
- SS7.2 Reduce heat island effect (roof). Provide roofing materials with solar reflectance index greater than 29 for sloped roofs greater than 2:12.
- SS8. Light pollution will be reduced by lighting site areas for safety and security using dark-sky fixtures with non-glare, cut-off fixtures. Building facade lighting will be minimal to none.

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### Water Efficiency

- WE** Water use reduction 20% lower than baseline for water use.
- WE1** Landscaping plant selection and captured roof rainwater to allow for a reduction by 50% (2 points) or 100% (4 points) of landscape irrigation. (Regional priority credit if no potable water used for irrigation.)
- WE2** Innovative Wastewater Technologies will be incorporated with water-conserving fixtures for 50% reduction.
- WE3** Water use reduction 30% or more lower than baseline for water use. Water use will be reduced by using waterless urinals, toilets and faucets.

### Energy and Atmosphere

- EAP1** Fundamental commissioning of building energy systems – A Commissioning Agent can be employed to verify that the building's energy systems are installed, calibrated and performing per the project's design intent. This is a required prerequisite if LEED certification is desired and has added cost implications.
- EAP2** Minimum energy performance – A whole-building energy simulation (energy modeling) required to demonstrate that the building performance has a 10% improvement over the minimum level of energy performance as defined by ASHRAE 90.1-2007. This is a required prerequisite if LEED certification is desired and has added cost implications.
- EAP3** Fundamental refrigerant management – CFC refrigerants will not be used in the building's HVAC systems.
- EA1** Minimum energy performance – A whole-building energy simulation (energy modeling) to demonstrate that the building performance has a 12% (1 credit) 48% (19 credits) improvement over the minimum level of energy performance as defined by ASHRAE 90.1-2007.
- The energy performance of the building will be optimized through an integrated design process that considers all components of the building including the building envelope, high-efficiency heating and cooling systems, lighting and lighting controls, Energy Star appliances and computers, natural daylighting. Focus on Energy may be able to provide engineering analysis and financial assistance to help achieve this goal and long-term cost savings. - N/A The project is under the \$2 Million dollar threshold as required by DFD Standards.
- EA2** On-site renewable energy – solar, wind, biomass and geothermal energy sources.
- EA3** Enhanced commissioning of building energy systems – A Commissioning Agent can be employed to provide design and submittal review as well as systems manuals and operations review.
- EA4** Enhanced refrigerant management – No (or restricted) use of refrigerants in the building's HVAC systems.
- EA5** Energy measurement and verification can be achieved through an ongoing accountability of energy consumption over time. This energy tracking can also be used as a public education tool as well.
- EA6** Green Power – Purchase a percentage of energy used from sustainable power sources.

### Materials and Resources

- MR.** Recyclables will be collected and stored on site to minimize landfill waste.
- MR1.1** Building reuse – N/A
- MR1.2** Building reuse – N/A
- MR2** Construction waste management will help divert over 75% of construction and demolition waste from the landfill through recycling and salvage.
- MR3** Materials will be salvaged and reused wherever possible. – N/A
- MR4** New materials for the new construction will be specified to include recycled content wherever practical.

## **Friends of Aztalan State Park: Visitor Center Preliminary Design**

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- MR5** Construction materials that are harvested, extracted and manufactured within 500 miles of the project will be specified wherever practical to encourage the use regional materials and minimize energy use associated with transport.
- MR6** Rapidly renewable materials will be specified wherever practical.
- MR7** This LEED credit requires the use of wood products from certified sustainably managed and harvested forests. This credit does add cost to the project.

### Indoor Environmental Quality

- IEQP1** The project will be designed for minimum indoor air quality per the ASHRAE standards 62.1-2007 for mechanically ventilated spaces.
- IEQP2** The building will be smoke free including areas near entrances and air intakes to maintain indoor air quality.
- IEQ1** Outdoor air delivery (CO2) monitoring to promote occupant comfort and well-being.
- IEQ2** Increased Ventilation – not recommended to provide additional outdoor air ventilation during heating and cooling seasons due to increased energy use.
- IEQ3.1** An indoor air quality management plan will be specified for the construction phases of the building project, including a building flush-out process.
- IEQ3.2** An indoor air quality management plan will be specified for the preoccupancy phase of the building project, using a building flush-out process.
- IEQ4.1** Low-emitting materials – Low VOC and low emitting adhesives and sealants will be specified.
- IEQ4.2** Low-emitting materials – Low VOC and low emitting paints and coatings will be specified.
- IEQ4.3** Low-emitting materials – Low VOC and low emitting carpet and flooring will be specified.
- IEQ4.4** Low-emitting materials – Low VOC and low emitting composite wood products can be specified if the budget permits.
- IEQ5** Indoor chemical and pollutant source controls will be incorporated including, entrance vestibule with walk-off grating/grilles, exhausted custodial supply storage and high performing ventilation filtration.
- IEQ6.1** Controllability of lighting systems – High level of lighting controls for building occupants and users, providing ambient and task lighting.
- IEQ6.2** Controllability of Thermal comfort – Provide individual comfort controls for 50% of building occupants, operable windows or controls to meet group needs and comfort.
- IEQ7.1** Thermal comfort to be designed to establish a comfort criteria per ASHRAE Standard 55-2004.
- IEQ7.2** Thermal comfort to be verified over time with a permanent monitoring system and post-occupancy follow up.
- IEQ8.1** Daylight and views - Provide daylight to 75% or more of regularly occupied spaces. (Regional priority credit.)
- IEQ8.2** Daylight and views - Provide line-of-sight views to the exterior from 90% or more of regularly occupied spaces.

### Innovation in Design

- ID1** 1 to 5 credits for innovative design features, exemplary performance, or educational features of sustainable design. Options include educational programing and information regarding the building's energy use/savings, exterior informational displays to promote native plantings and storm water management, green building maintenance, increased construction waste recycling, etc.
- ID2** LEED Accredited Professional as part of project team.

Regional Priority Credits (see above for up to 4 credits)

Project  
Project No.  
Project Stage  
Checklist Author

**Aztalan State Park Visitor Center**  
**Project No.**  
**Preliminary Design**  
**Dimension IV Madison Design Group**

3/27/2015

Applicable?	Requirements	Primary Responsibility	Remarks Note any: Reason if Unknown or Not Applicable, Any goals beyond Min. Req'ts., Other comments
<b>1. Portfolio Management &amp; Assessment of Need</b>			
Yes	** Portfolio Management & Assessment of Need	A	Site Masterplan 6/2003
<b>2. Program Development</b>			
Yes	** Program Development	A	Site Masterplan 6/2003
<b>3. Integrated Design</b>			
Yes	** Integrated Design	D, DSF	Design Team Meetings Held
<b>4. Sustainable Site Requirements</b>			
Yes	SS W1/P1 * Construction Site Erosion & Sedimentation Control	D/C	Erosion Control & SWMP In Progress
Yes	SS C1 Site Selection	A	Site Masterplan 6/2003
No	SS C2 Development Density & Community Connectivity	A	Site Selection per Masterplan 6/2003
No	SS C3 Brownfield Redevelopment	A	State Park Property
No	SS C4.1 Alternative Transportation Public Transportation Access	A	No Existing Public Transportation
No	SS C4.2 * Alternative Transportation Bicycle Storage & Changing Rooms	D	No Showering Facilities in State Park
Yes	SS C4.3 * Alternative Transportation Low Emitting & Fuel Efficient Vehicles	D	Min 5% of Parking Capacity Available
No	SS C4.4 Alternative Transportation Parking Capacity	A	Parking Per Masterplan 6/2003
Yes	SS C5.1 Site Development, Protect or Restore Habitat	A/D	Greenfield Site Limits
Yes	SS C5.2 Reduced Site Disturbance Development Footprint	A/D	Site Masterplan 6/2003
Yes	SS C6.1 Permanent Stormwater Management (Discharge Rate & Vol - DNR 151)	D	Roof Water Captured for Irrigation
Yes	SS C6.2 * Permanent Stormwater Management (Quality Treatment - DNR 151)	D	On-Site Infiltration Measures
Yes	SS C7.1 Heat Island Effect: Non-Roof	D	Shade & High Albedo & Open Grid Pavers
	SS C7.2 LEED Credit Not Used		
Yes	SS C8 Light Pollution Reduction	D	Meets/Exceeds IESNA RP-33-99
<b>5. Water Efficiency Requirements</b>			
	WE C1.1 Incorporated into WE C1.2		
Yes	WE C1.2 Water Efficient Landscaping No Potable Use or No Irrigation	D	Roof Water Captured for Irrigation
	WE C2 LEED Credit Not Used		
Yes	WE C3.1 Water Use Reduction, 20% Reduction	D	Min 20% Less Than 1992 EPA
	WE C3.2 LEED Credit Not Used		
<b>6. Energy &amp; Atmosphere Requirements</b>			
Yes	EA P1 * Commissioning	D, C	Level 1
Yes	EA P2 Minimum Energy Performance	D	Ashrae 90.1/2007 & DSF Guidelines
Yes	EA P3 * CFC Reduction in HVAC&R Equipment	D	Option 2
No	EA C1 * Optimize Energy Performance for Projects > \$2 million	D	< \$2 million
Yes	EA C2 * Renewable Energy	D	Onsite Water & Roof Water Irrigation
	EA C3 Incorporated into EA P1		
	EA C4 LEED Credit Not Used		
Yes	EA C5 * Measurement & Verification	D, O	Building Automation System & Metering
?	EA C6 Green Power	A, O	

DSF Requirement / LEED Credit Comparison		Primary Responsibility
Same as LEED 2.1 or 2.2 Credit		A Agency - Planning, Budget Analyst
* DSF variation of LEED 2.1 or 2.2 Credit		D Architect/Engineer
** DSF only Standard		DSF Division of State Facilities
LEED Credit Not Used, Incorporated into another Standard or not supported		C Contractor
		O Agency - Operation & Maintenance

Project No. <b>Aztalan State Park Visitor Center</b>		42090	
Applicable?	Requirements	Primary Responsibility	Remarks Note any: Reason if Unknown or Not Applicable, Any goals beyond Min. Req'ts., Other comments
<b>7. Materials &amp; Resources Requirements</b>			
Yes	MR P1 Storage & Collection of Recyclables	D	Recyclables Area Per Plan
No	MR C1.1 Building Reuse	A	Not Applicable
	MR C1.2 Incorporated into MR C1.1		
	MR C1.3 LEED Credit Not Used		
Yes	MR C2.1 Construction Waste Management	C	Waste Management Plan Per Specs
	MR C2.2 Incorporated into MR C2.1		
No	MR C3.1 Resource Reuse	D	<10%
	MR C3.2 Incorporated into MR C3.1		
Yes	MR C4.1 Recycled Content	D	10-20%
	MR C4.2 Incorporated into MR C4.1		
Yes	MR C5.1 Local/Regional Materials	D	>20% within 500 miles
	MR C5.2 LEED Credit Not Used		
No	MR C6 Rapidly Renewable Materials	D	< 5%
Yes	MR C7 * Certified Wood	D	> 70%
Yes	MR W1 ** Durable Buildings	D	Durable Building Plan Per Specs
<b>8. Indoor Environmental Quality Requirements</b>			
Yes	EQ P1 Minimum IAQ Performance	D	Meet/Exceed Ashrae 62.1 / 2004 SS4-7
Yes	EQ P2 * Environmental Tobacco Smoke (ETS) Control	O	No Smoking Policy and Signage
	EQ C1 LEED Credit Not Used		
	EQ C2 LEED Credit Not Used		
Yes	EQ C3.1 Construction IAQ Management Plan During Construction	C	IAQ Management Plan Per Specs
Yes	EQ C3.2 Construction IAQ Management Plan Before Occupancy	C	IAQ Management Plan Per Specs
Yes	EQ C4.1 Low-Emitting Materials Adhesives & Sealants	D	Low-VOC Materials Per Specs
Yes	EQ C4.2 Low-Emitting Materials Paints	D	Low-VOC Materials Per Specs
Yes	EQ C4.3 Low-Emitting Materials Carpet	D	Low-VOC Materials Per Specs
Yes	EQ C4.4 Low-Emitting Materials Composite Wood	D	No Urea-Formaldehyde Per Specs
Yes	EQ C5 Indoor Chemical & Pollutant Source Control	D	Walk-off Mat & Chem Storage Exhaust
	EQ C6.1 LEED Credit Not Used		
	EQ C6.2 LEED Credit Not Used		
	EQ C7.1 LEED Credit Not Used		
	EQ C7.2 LEED Credit Not Used		
Yes	EQ C8.1 * Daylight & Views	D	Per Calculations
	EQ C8.2 LEED Credit Not Used		
<b>9. Operation &amp; Maintenance Requirements</b>			
?	** Operation & Maintenance	O	
<b>10. Purchasing of Furniture, Fixtures and Equipment Requirements</b>			
?	** Purchasing of Furniture, Fixtures and Equipment	A	
<b>11. Accountability, Verification, and Reporting Requirements</b>			
?	AR 1 ** Accountability for Sustainability	DSF	
?	AR 2 ** Verification during Project Design	DSF	
?	AR 3 ** Verification during Project Construction	DSF	
?	AR 4 ** Verification following Construction	DSF	
?	AR 5 ** Reporting on Construction Results	DSF	
<b>LEED Goals</b>			
No	Seeking LEED Certification	A	Min LEED-Silver Per NC-2009
Yes	LEED EB (Agency Operations Equal to LEED Existing Building)	A	
DSF Requirement / LEED Credit Comparison		Primary Responsibility	
Same as LEED 2.1 or 2.2 Credit		A	Agency - Planning, Budget Analyst
* DSF variation of LEED 2.1 or 2.2 Credit		D	Architect/Engineer
** DSF only Standard		DSF	Division of State Facilities
		C	Contractor
LEED Credit Not Used, Incorporated into another Standard or not supported		O	Agency - Operation & Maintenance



# Friends of Aztalan State Park: Visitor Center Preliminary Design

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## LEED 2009 Checklist

LEED 2009 for New Construction and Major Renovations		Project Name	
Project Checklist		Date	
<b>Sustainable Sites</b> Possible Points: 26			
Y	N		
11		Prereq 1	Construction Activity Pollution Prevention
		Credit 1	Site Selection
		Credit 2	Development Density and Community Connectivity
		Credit 3	Brownfield Redevelopment
		Credit 4.1	Alternative Transportation—Public Transportation Access
		Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms
		Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles
		Credit 4.4	Alternative Transportation—Parking Capacity
		Credit 5.1	Site Development—Protect or Restore Habitat
		Credit 5.2	Site Development—Maximize Open Space
		Credit 6.1	Stormwater Design—Quantity Control
		Credit 6.2	Stormwater Design—Quality Control
		Credit 7.1	Heat Island Effect—Non-roof
		Credit 7.2	Heat Island Effect—Roof
		Credit 8	Light Pollution Reduction
4			<b>Water Efficiency</b> Possible Points: 10
Y		Prereq 1	Water Use Reduction—20% Reduction
		Credit 1	Water Efficient Landscaping
		Credit 2	Innovative Wastewater Technologies
		Credit 3	Water Use Reduction
7			<b>Energy and Atmosphere</b> Possible Points: 35
Y		Prereq 1	Fundamental Commissioning of Building Energy Systems
		Prereq 2	Minimum Energy Performance
		Prereq 3	Fundamental Refrigerant Management
		Credit 1	Optimize Energy Performance
		Credit 2	On-Site Renewable Energy
		Credit 3	Enhanced Commissioning
		Credit 4	Enhanced Refrigerant Management
		Credit 5	Measurement and Verification
		Credit 6	Green Power
6			<b>Materials and Resources</b> Possible Points: 14
Y		Prereq 1	Storage and Collection of Recyclables
		Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof
		Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements
		Credit 2	Construction Waste Management
		Credit 3	Materials Reuse
<b>Materials and Resources, Continued</b>			
Y	N		
		Credit 4	Recycled Content
		Credit 5	Regional Materials
		Credit 6	Rapidly Renewable Materials
		Credit 7	Certified Wood
12			<b>Indoor Environmental Quality</b> Possible Points: 15
Y		Prereq 1	Minimum Indoor Air Quality Performance
		Prereq 2	Environmental Tobacco Smoke (ETS) Control
		Credit 1	Outdoor Air Delivery Monitoring
		Credit 2	Increased Ventilation
		Credit 3.1	Construction IAQ Management Plan—During Construction
		Credit 3.2	Construction IAQ Management Plan—Before Occupancy
		Credit 4.1	Low-Emitting Materials—Adhesives and Sealants
		Credit 4.2	Low-Emitting Materials—Paints and Coatings
		Credit 4.3	Low-Emitting Materials—Flooring Systems
		Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products
		Credit 5	Indoor Chemical and Pollutant Source Control
		Credit 6.1	Controllability of Systems—Lighting
		Credit 6.2	Controllability of Systems—Thermal Comfort
		Credit 7.1	Thermal Comfort—Design
		Credit 7.2	Thermal Comfort—Verification
		Credit 8.1	Daylight and Views—Daylight
		Credit 8.2	Daylight and Views—Views
6			<b>Innovation and Design Process</b> Possible Points: 6
		Credit 1.1	Innovation in Design: MRC2 - Divert ≥ 95%
		Credit 1.2	Innovation in Design: MRC5 - Regional Materials >40%
		Credit 1.3	Innovation in Design: MRC7 - FSC Wood >95%
		Credit 1.4	Innovation in Design: IEQc8.1 - Daylight ≥ 95%
		Credit 1.5	Innovation in Design: IEQc8.2 - Views 100%
		Credit 2	LEED Accredited Professional
4			<b>Regional Priority Credits</b> Possible Points: 4
		Credit 1.1	Regional Priority: SSC5.1
		Credit 1.2	Regional Priority: SSC5.2
		Credit 1.3	Regional Priority: SSC6.1
		Credit 1.4	Regional Priority: WEC1
50			<b>Total</b> Possible Points: 110

# DAYLIGHTING CRITERIA FORM<sup>1</sup>

USED TO SHOW COMPLIANCE WITH DSF DAYLIGHTING STANDARDS FOR STATE FACILITIES

CRITERIA		SCHEMATIC DESIGN <sup>2</sup>	PRELIMINARY DESIGN	FINAL DESIGN
<b>1. WINDOW-WALL RATIO</b>	NORTH ELEVATION [70% /50%]	30%	206/865 SF 24%	
	EAST ELEVATION [30%/22%]	30%	250/896 SF 28%	
	SOUTH ELEVATION [30%/26%]	30%	258/997 SF 26%	
	WEST ELEVATION [30%/22%]	30%	237/897 SF 24%	
<b>2. GLASS PERFORMANCE</b>				
2A. VIEW GLASS				
	SC [.38 Std./0.22 Pref.]		.26 SHCG ( .30 SC)	
	V <sub>T</sub> [38% Std./18% Pref.]		34%; (15% if reflective)	
	U-VALUE (optional)		.27	
2B. DAYLIGHTING GLASS				
SHADED	SC [0.38 Std./0.38 Pref.]			
	V <sub>T</sub> [38% Std./38% Pref.]			
	U-VALUE (optional)			
UNSHADED	SC [0.38 Std / 0.26 Pref.]		.18 SHCG ( .21 SC)	
	V <sub>T</sub> [38% Std./23% Pref.]		22 %	
	U-VALUE (optional)		.30	
<b>ORIENTATION OF BUILDING</b> DEGREES E OR W OF NORTH/SOUTH AXIS				
<b>3. LIGHTING POWER DENSITY (LPD)</b> [1.0 Std/ 0.8 Pref. W/sf]				
<b>4. WINDOW TREATMENTS</b>		<i>Provide Statement</i>	<i>Provide Statement</i>	
<b>5. CEILING HEIGHTS</b> [9'-0" min/9'-6" to 10'0" pref.]			10'-3"	
<b>6. INTERIOR FINISH REFLECTANCES</b> CEILING [80% Std./ 80-90%+ Pref.] WALL ABOVE PICT. RAIL [50% Std./ 80%+ Pref.] BELOW PICT. RAIL [50% Std./ 50%+ Pref.]			84% - CEILING TILE	
<b>7. LIGHTING CONTROLS</b>		<i>Provide Statement</i>	<i>Provide Statement</i>	
<b>8. EXTERIOR SOLAR SHADING</b>		<i>Provide Statement</i>	<i>Provide Statement</i>	

THE FOLLOWING ARE NOT DESIGN CRITERIA, BUT ARE USEFUL IN ASSESSING HVAC COOLING LOAD REDUCTIONS:

<b>CALCULATED COOLING AIR FLOW</b> TOTAL SUPPLY FAN OUTPUT IN CFM PER NET S.F. OF AIR-CONDITIONED SPACE			
<b>CALCULATED AIR CONDITIONING LOAD</b> NET S.F. PER INSTALLED TON OF AIR CONDITIONING			

<sup>1</sup> For large structures (esp. if multi-wing and/or irregularly shaped) the needed information may not neatly or clearly fit into this form. It is the A/E's responsibility to submit multiple forms, or to re-format so that typical conditions for the entire building are *clearly* shown.

<sup>2</sup> Design intent is adequate at schematic design stage.



## **Friends of Aztalan State Park: Visitor Center Preliminary Design**

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### **DSF Daylighting Standards**

#### **1) Window Treatment**

Roller shades and integrated between-pane shades in applicable windows.

#### **2) Lighting Controls**

- Per Electrical

#### **3) Exterior Solar Shading**



**DIVISION OF FACILITIES  
DEVELOPMENT**

WISCONSIN DEPARTMENT OF ADMINISTRATION

**ENERGY CONSERVATION  
MEASURES (ECM's) FORM**

<b>PROJECT:</b>	AZTALAN STATE PARK VISITOR CENTER	<b>PROJECT NO.:</b>	
<b>LOCATION:</b>	AZTALAN, WI	<b>DATE:</b>	03/27/2015

BUILDING SYSTEM	ENERGY CONSERVATION MEASURES (ECM's)	DISCOUNTED ENERGY PAYBACK CALC.		
		YES	NO	YEARS
<b>1. ENVELOPE</b>	1.1 Continuous Exterior Insulation			
	1.2 Underslab Insulation			
	1.3 Triple pane Low-E Windows			
	1.4			
	1.5			
	1.6			
	1.7			
<b>2. PLUMBING</b>	2.1 Low Flow Fixtures			
	2.2 Dual Flush Controls			
	2.3			
	2.4			
	2.5			
	2.6			
	2.7			
<b>3. HVAC</b>	3.1 Zoned Building Control			
	3.2 Operable Windows for Natural Ventilation			
	3.3			
	3.4			
	3.5			
	3.6			
	3.7			
<b>4. ELECTRICAL</b>	4.1 LED Lighting			
	4.2 Occupancy Sensors			
	4.3 Variable light controls			
	4.4			
	4.5			
	4.6			
	4.7			
<b>5. OTHER</b>	5.1 Building Automation			
	5.2			
	5.3			
	5.4			
	5.5			
	5.6			
	5.7			

## Friends of Aztalan State Park: Visitor Center Preliminary Design

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### Building Code Analysis

Wisconsin Enrolled Commercial Building Code, Dated 2009 w/ Wisconsin extensions

#### Occupancy:

Assembly	A-3	Exhibit/Multi-purpose Room
Business	B	(DNR Office)
Mercantile	M	(Gift Shop)

#### Occupancy Separations/Fire Ratings:

Business uses can be included as non-separated use following A-3 allowable area/height restrictions. (IBC 508.3).

Furnace/boiler/HVAC rooms: No rating

Corridors serving more than 30: No rating

Accessory uses (aggregate less than 10% of floor area) does not require separation.

#### Construction Type: VB(assumed)

Construction Type V any construction material permitted (combustible construction; ie. wood)

Primary structural frame: No rating required

Exterior and interior bearing walls: No rating required

Floor and roof construction: No rating required

No rating required at interior non-bearing interior walls and partitions.

No rating required at exterior non-bearing walls if over 30' fire separation distance.

No limit on exterior wall openings if over 30' fire separation distance (IBC Table 705.8).

Non-Sprinkled (Occupancy A-3 requires automated sprinkler system throughout where fire area exceeds 12,000 sf or occupancy capacity exceeds 300. IBC 903.2.1.3.)

#### Allowable heights and areas (IBC Chapter 5 and Table 503):

1 stories

40' height

6,000 sf area limit

Building height = grade plane to average height of roof surface

#### Fire Lanes (Int. Fire Code 2009 – confirm specific requirements with local fire department):

Within 150' of any part of exterior.

Minimum width: 20'.

Minimum vertical clearance: 13'-6"

(Public streets can be used as firelane if requirements met.)

Inside turning radius: as determined by the fire code official (28' the previous minimum).

A dead-end fire lane longer than 150' requires an approved turnaround.

#### Exit width and quantity:

Maximum floor area per occupant (IBC Table 1004.1.1):

Assembly – standing space: 5 net

Assembly – concentrated, chairs only: 7 net

Assembly – unconcentrated, tables and chairs: 15 net

Business Areas: 100 gross

Storage: 300 gross

Mechanical and equipment rooms: 300 gross

#### Maximum occupant load with one exit:

Assembly, business and mercantile: 49 occupants

Storage: 29 occupants

Occupant capacity 195

Minimum exits per story: 2 (1-500 occupants) IBC Table 1021.1.

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Minimum egress width (IBC 1005.1):

Egress components other than stairs: 0.2" per occupant.

$195 \text{ occupants} \times .2" = 39"$  (two 36" doors required)

Multiple means of egress shall be sized so that the loss of any one means of egress shall not reduce the available capacity to less than 50% of the required capacity.

Doors shall not reduce egress width by more than 7" when fully open and not by more than 50% in any position. (IBC 1005.2)

Egress route:

Maximum travel distance: 200 feet (IBC Table 1016.1).

Where 2 exit doors are required, the doors must be separated by a distance greater than 1/2 maximum diagonal distance of space served (IBC 1015.2.1).

Corridor width: 44" minimum (IBC 1018.2).

Dead-End Corridors: 20 feet maximum length, or length  $< 2 \frac{1}{2}$  times the least width. (IBC 1018.4)

Common path of travel: 75 feet maximum before two, distinct paths of egress travel. IBC 1014.3

Assembly main exit. If occupant load over 300, main exit required for 50% of occupant load. (IBC 1018.2)

Ceiling height: 7'-6" minimum in means of egress (IBC 1003.2)s, 6'-8" in stairways (IBC 1009.2).

Protruding objects: 4" maximum projection between 27" and 80" above the floor, and may not reduce the minimum clear width required.

Accessibility per IBC chapter 11 and ICC/ANSI 117.1 2003.

At least 60% of public entrances to be accessible.

Accessible parking stalls: 2 (26 to 50 stalls); 3 (51 to 75 stalls), one van accessible stall for every six accessible stalls required.

Plumbing Fixtures:

See IBC Table 2902.1 for assembly occupancy (halls, libraries, etc.) toilet and lavatory requirements.

195 occupancy = 98 male and 98 female

Male:  $98 \times 1/125 = 2$  required = 1 toilet + 1 urinal (Int. Plumbing Code allows 67% of required toilets to be urinals for assembly occupancies)

$98 \times 1/200 = 2$  lavatories required

Female:  $98 \times 1/65 = 2$  toilets required

$98 \times 1/200 = 2$  lavatories required

Service sink required for assembly occupancies.

Two drinking fountains required for assembly occupancies.

**Friends of Aztalan State Park: Visitor Center Preliminary Design**

Aztalan, Wisconsin

June 15, 2015

**Project Cost Estimate**

Date: June 10, 2015

Concept:

Final

Project: Aztalan State Park Visitor Center

Phase:

Preliminary Design

---

Site Acquisition .....	\$0
Abatement .....	\$0
Site Development (Grading / Parking lot / Site Clearing).....	\$116,750
Phase 1 (Grading for building).....	\$28,500
Phase 2 (Parking Lot).....	\$88,250
Building Construction (3,155 GSF).....	\$795,500
General .....	\$526,000
Plumbing.....	\$57,000
HVAC.....	\$118,500
Electrical .....	\$94,000
General Conditions.....	\$141,000
Fixed Equipment (Casework, miscellaneous).....	Included Above
Low Voltage System (Phone, data, security, sound, PCs, miscellaneous) .....	Included Above
Furnishings & Movable Equipment (~10%) .....	\$80,000
Sitework (Well/Septic/Landscaping/sidewalks.).....	\$56,000
SUBTOTAL.....	\$1,189,150
Contingency (~7%).....	\$83,250
TOTAL: .....	\$1,272,500
UNIT COST (Per Square Foot at 3,155 GSF, rounded).....	\$403.40

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Professional Design Fees.....	\$97,000
Exhibit Design Fees.....	\$10,000
Miscellaneous Costs.....	\$18,000
Topographical Survey.....	\$2,200
Soil Testing .....	\$5,000
Electrical Utility .....	\$10,000
Agency Review.....	\$800

TOTAL PROJECT COST .....\$1,397,500

## Friends of Aztalan State Park: Visitor Center Preliminary Design

Aztalan, Wisconsin

June 15, 2015

---

### Operating Utilities Cost Estimate

Date: June 15, 2015

Concept:

Final

Project: Aztalan State Park Visitor Center

Phase:

Preliminary Design

---

Sewer and Water.....\$20/ month

The Above cost is an estimate of electrical cost associated with pumping.

LP gas .....\$2,400/ year

Therm prices have stabilized, but until we have a definitive HVAC design it is difficult to predict. Propane gas bill based on \$0.75/SF/Year

Electricity .....\$3,155/ year

KWH prices have continued to modestly increase, until we have a definitive electrical and air condition design it is difficult to predict. Electric bill based on \$1.00/SF/year

Phone/ data .....\$800/ year

TV .....\$600/ year

## Friends of Aztalan State Park: Visitor Center Preliminary Design

Aztalan, Wisconsin

June 15, 2015

---

### Concept Design Schedule Milestones

#### Community Involvement

- September 14, 2014
- October 6, 2014
- October 30, 2014
- November, 14-30 2014
- December 07, 2014

Pre Kick-off site visit  
Architect Kick-off Meeting with FOASP Board  
Public Listening Session  
Survey Input Period – Two Weeks  
Building Committee Input Review Meeting

#### Concept Design

- December 10, 2014
- January 24, 2015
- January 28, 2015
- February 19, 2015
- March 3, 2015
- March 18, 2015
- June 15, 2015

Construction Manager RFP Issued  
Construction Manager Approved by FOASP Board  
CMA Kick-off Meeting  
Building Committee Schematic Design Review  
Consultant Meeting - Preliminary Design  
Submit Draft of Preliminary Design Report  
Submission of finalized Preliminary Design Report

#### Construction Documents

- Present - ?

Fundraising

#### Construction Documents

- TBD
- TBD
- TBD
- TBD

Approval to proceed with Plans and Specs  
Committee Meeting to review 50% Plans  
Committee Meeting to review 99% Plans and Specs  
DOA/DNR Review and Approval

#### Bidding

- TBD
- TBD
- Week of

Approval to advertise and release for Bids  
Bid Opening  
Award of Construction Contract

#### Construction

- TBD
- TBD
- TBD
- TBD

Start of Construction  
Furniture, Fixtures & Equipment procurement  
Substantial Completion of Building Construction  
Furniture, Fixtures & Equipment install

#### Occupancy

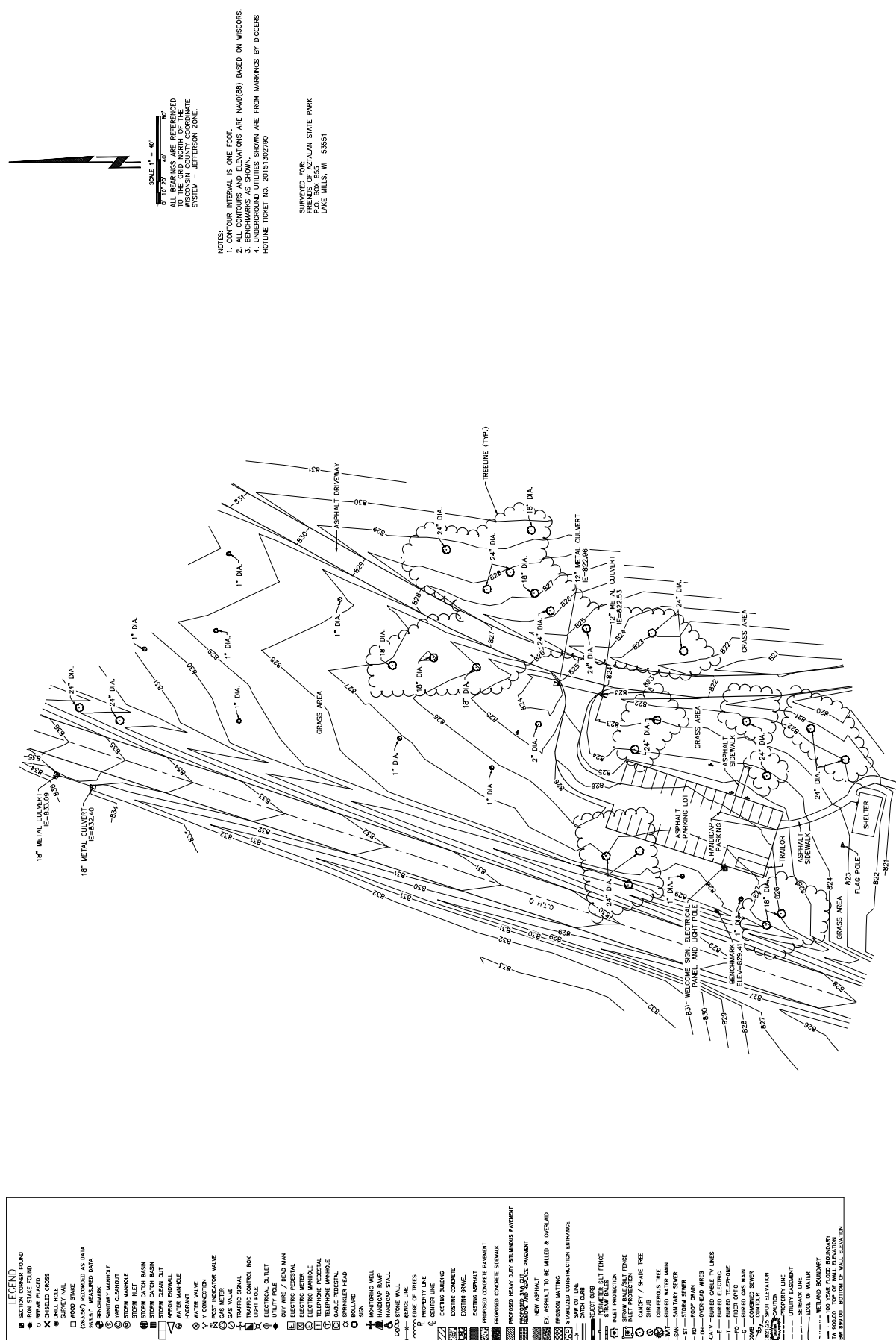
- TBD

Grand Opening Ceremony









NOTES:  
1. CONTOUR INTERVAL IS ONE FOOT.  
2. ALL CONTOURS AND ELEVATIONS ARE NAVD(83) BASED ON WISCONSIN.  
3. BENCHMARKS AS SHOWN.  
4. ALL ELEVATIONS ARE FROM MARKINGS BY DIGGERS.  
HOTLINE TICKET NO. 20151302780

SURVEYED FOR:  
FRIENDS OF AZTALAN STATE PARK  
LAKE MILLS, WI 53551

SCALE 1" = 40'  
0' 10' 20' 30' 40' 50' 60' 70' 80'

UTM ZONE 18N  
EASTING 600,000  
NORTHING 4,500,000  
WISCONSIN COUNTY COORDINATE  
SYSTEM - JEFFERSON ZONE.

**DIMENSION**  
Mediam Design Group  
architecture • engineering • interior design  
615 Grant "John" Road, Suite 120  
Madison, Wisconsin 53719  
608.529.4444 888.329.4445  
dimensionmedia.com

**OTIE**  
Ozaukee Trail Integrated Enterprises  
100 EASTERN BLVD., SUITE 200  
OZAUKEE, WISCONSIN 53099  
608.241.9710

FRIENDS OF  
AZTALAN STATE  
PARK: VISITOR  
CENTER  
PRELIMINARY  
DESIGN

AZTALAN, WI

DATE OF ISSUE: 05/21/2015

REVISIONS:	
1	EXIST 1

PROJECT # 14098

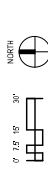
GRADING PLAN -  
PHASE I

C200



1 GRADING PLAN - PHASE I

1" = 30'



**DIMENSION**  
Mediam Design Group  
architecture • engineering • interior design  
6515 Grand Zebra Place, Suite 120  
Madison, Wisconsin 53719  
608.529.4444 800.329.4445  
dimensionmd.com

**OTIE**  
Ozark Trail Integrated Enterprises  
1000 EASTERN BLVD, SUITE 300  
MADISON, WISCONSIN 53717  
608.241.9710

FRIENDS OF  
AZTALAN STATE  
PARK: VISITOR  
CENTER  
PRELIMINARY  
DESIGN

AZTALAN, WI

DATE OF ISSUE: 05/21/2015

REVISIONS:	
1	DATE: 1

PROJECT # 14098

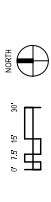
GRADING PLAN -  
PHASE II

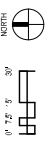
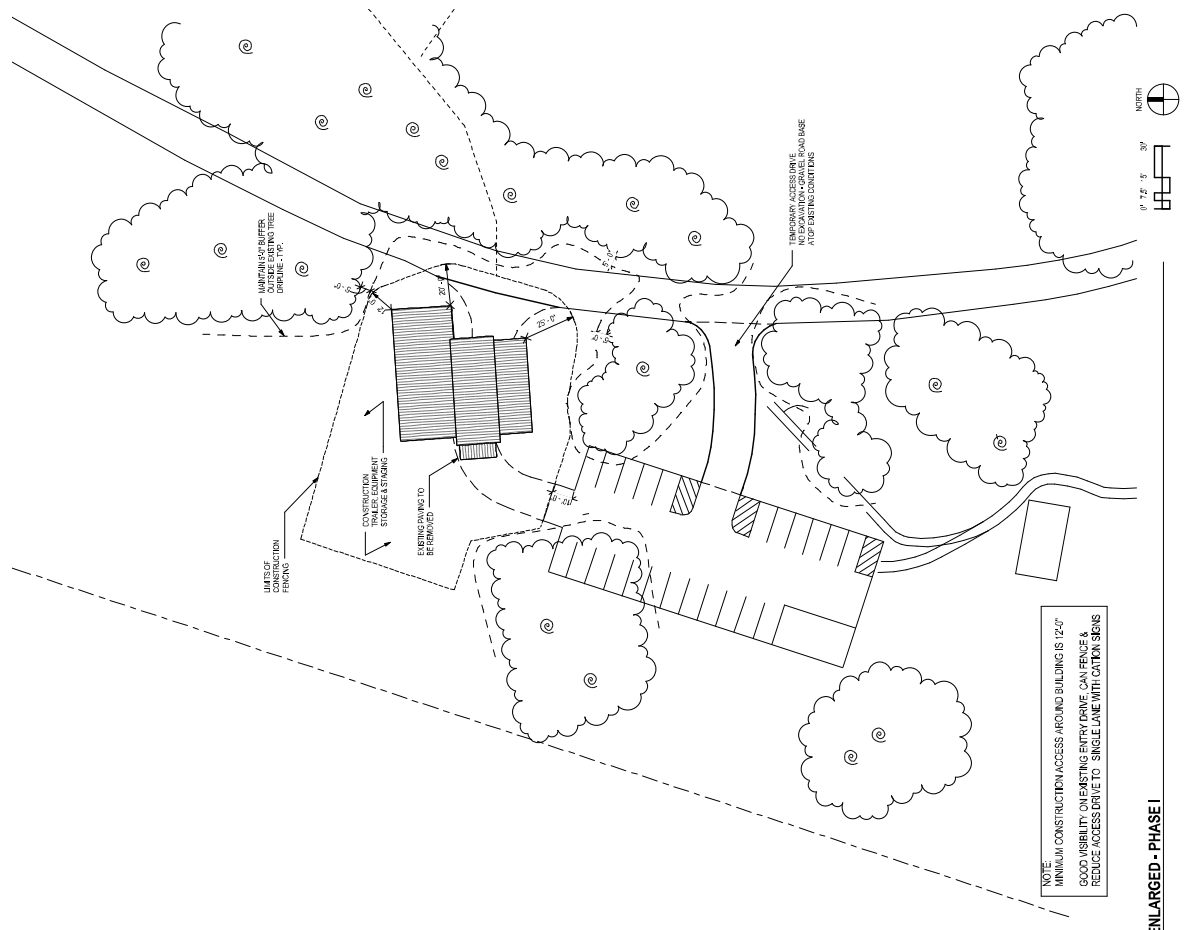
C201



1 GRADING PLAN - PHASE II

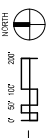
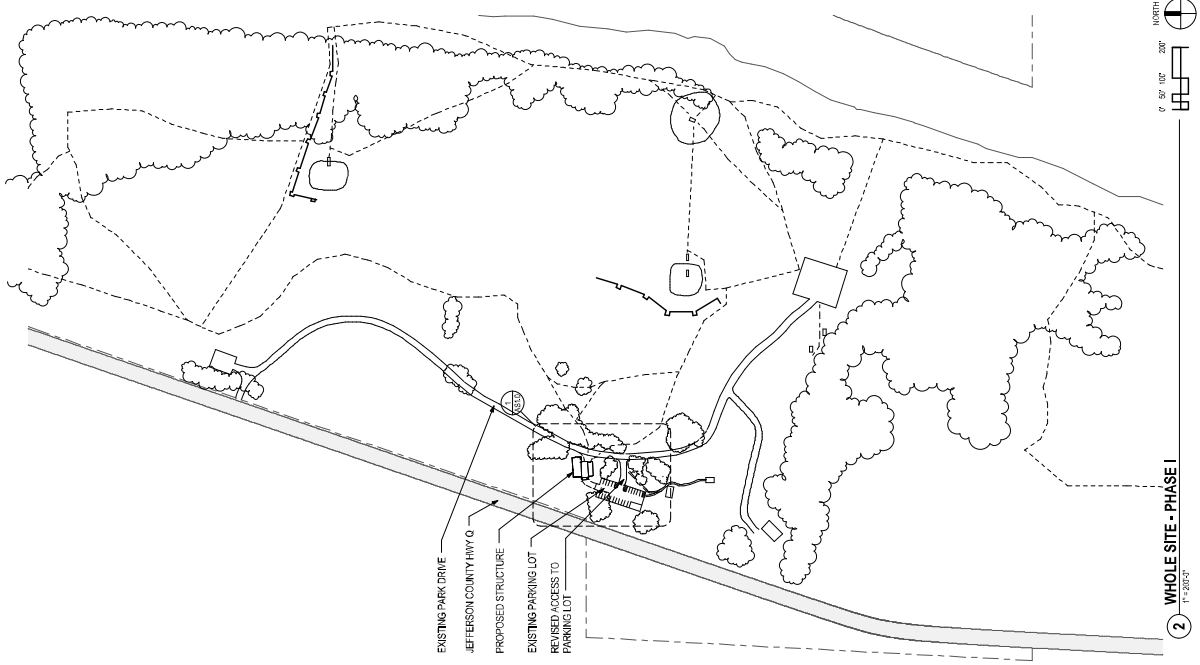
1" = 30'





1 SITE PLAN ENLARGED - PHASE I  
1" = 30'-0"

**DIMENSION**  
Madison Design Group  
Architecture • Engineering • Interior Design  
650 Jackson Park Square, Suite 200  
Madison, Wisconsin 53715  
608.526.4444  
info@dimensiondsg.com



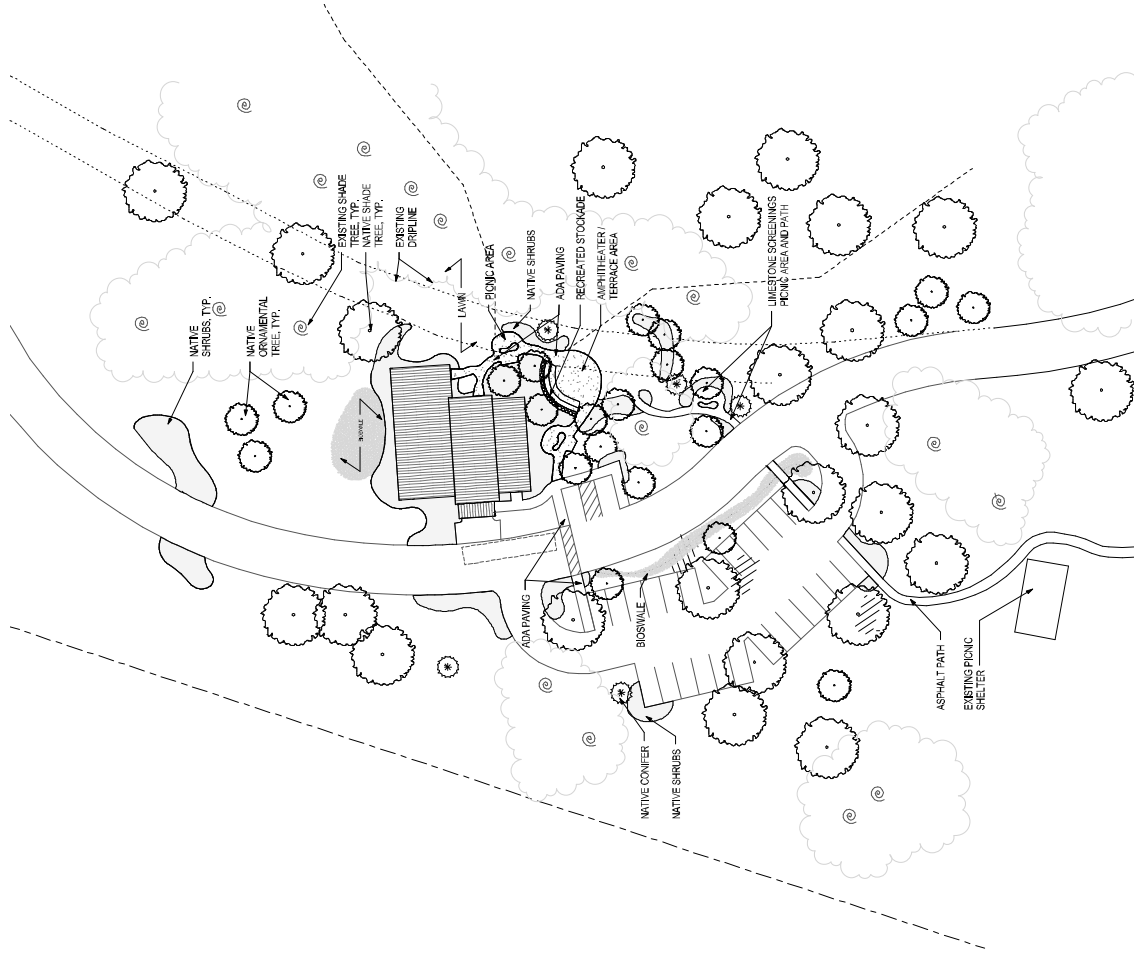
2 WHOLE SITE - PHASE I  
1" = 200'-0"

FRIENDS OF AZTALAN STATE PARK: VISITOR CENTER PRELIMINARY DESIGN

AZTALAN, WI  
SITE PLAN PHASE I  
02/29/2016  
1488





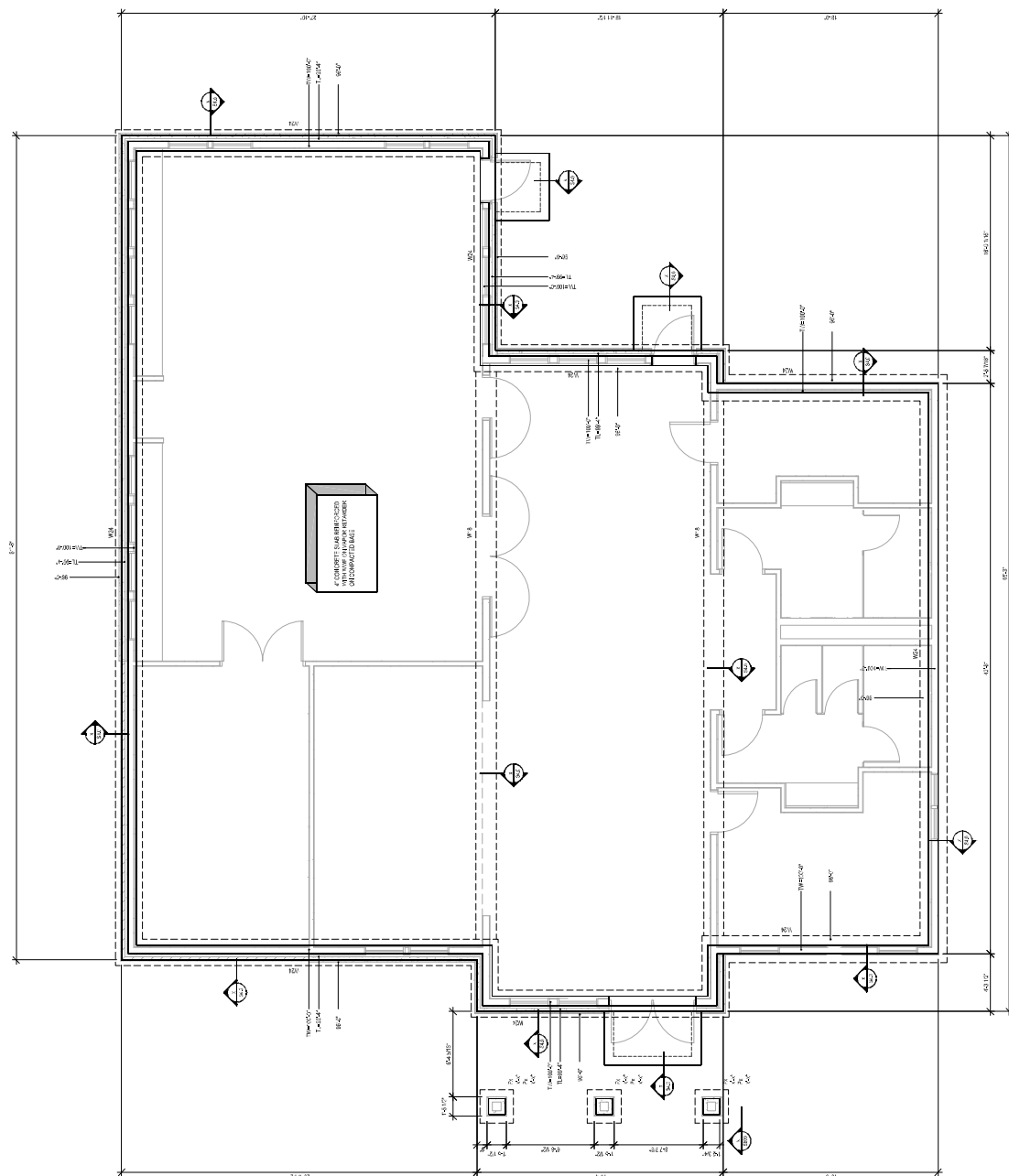


1 SITE PLAN ENLARGED - PHASE II LANDSCAPE  
P. 367

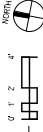
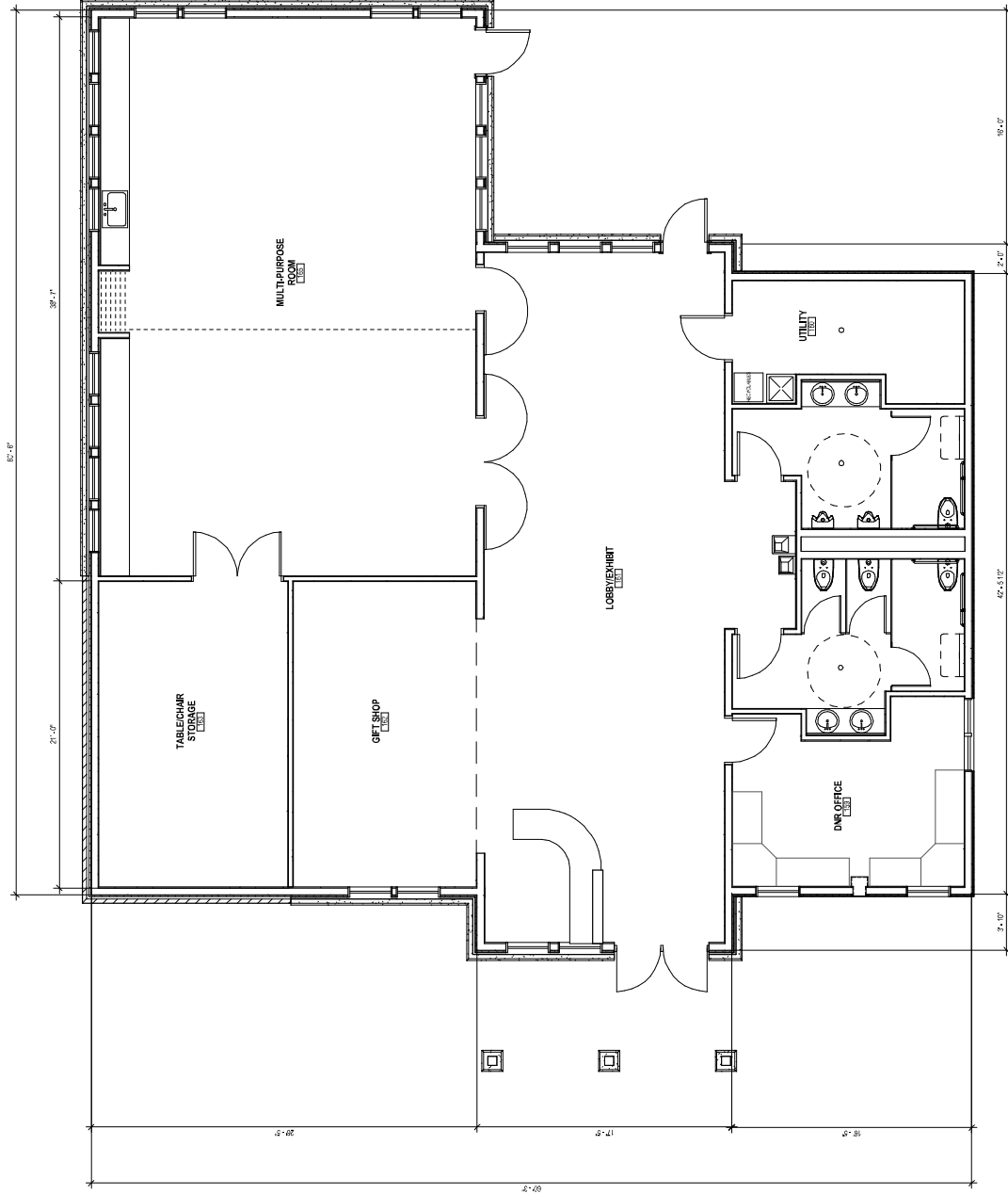
# FRIENDS OF AZTALAN STATE PARK: VISITOR CENTER PRELIMINARY DESIGN





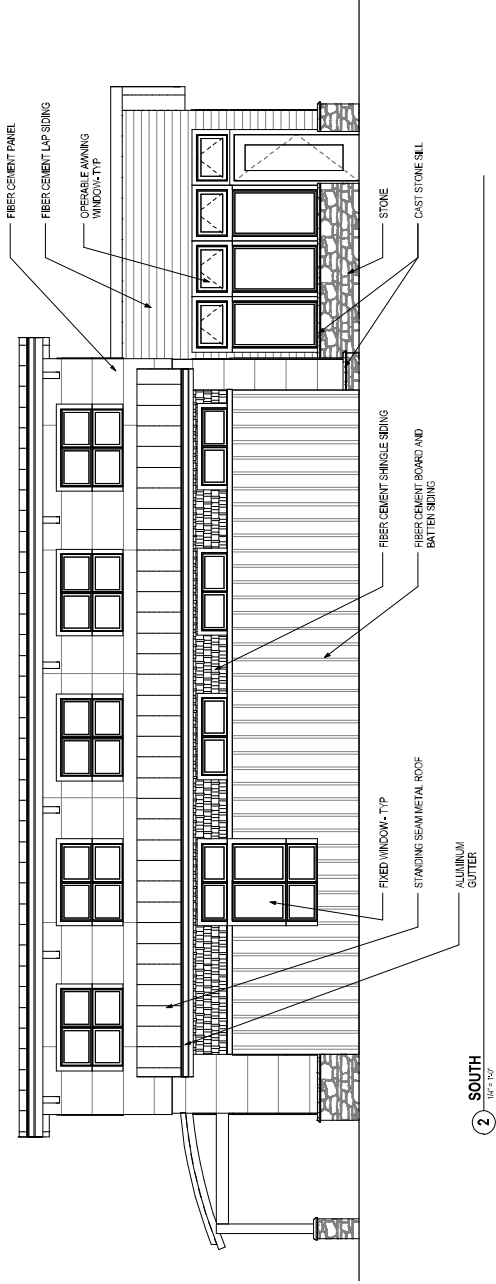
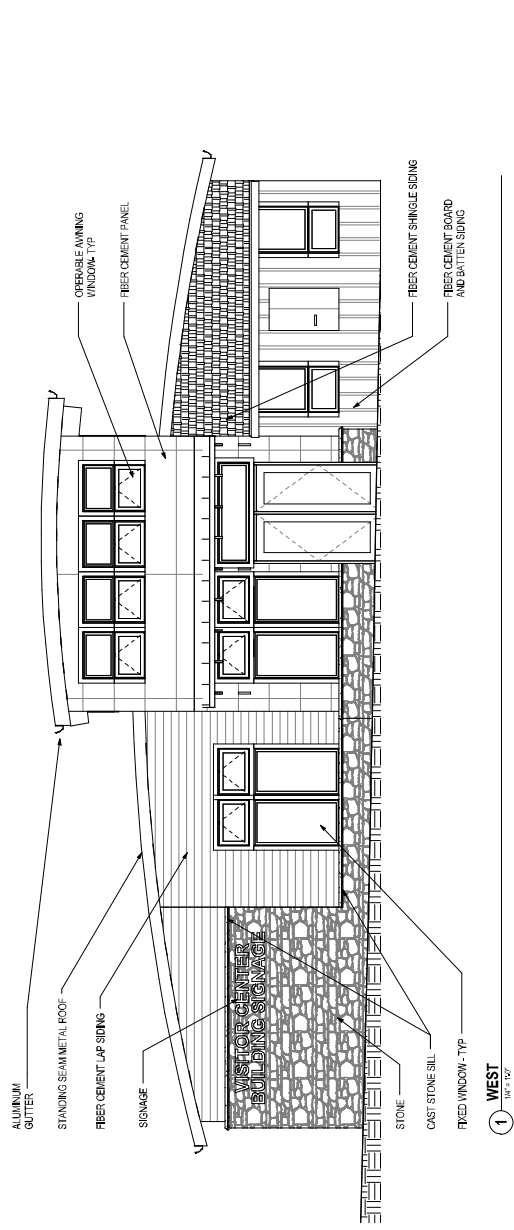




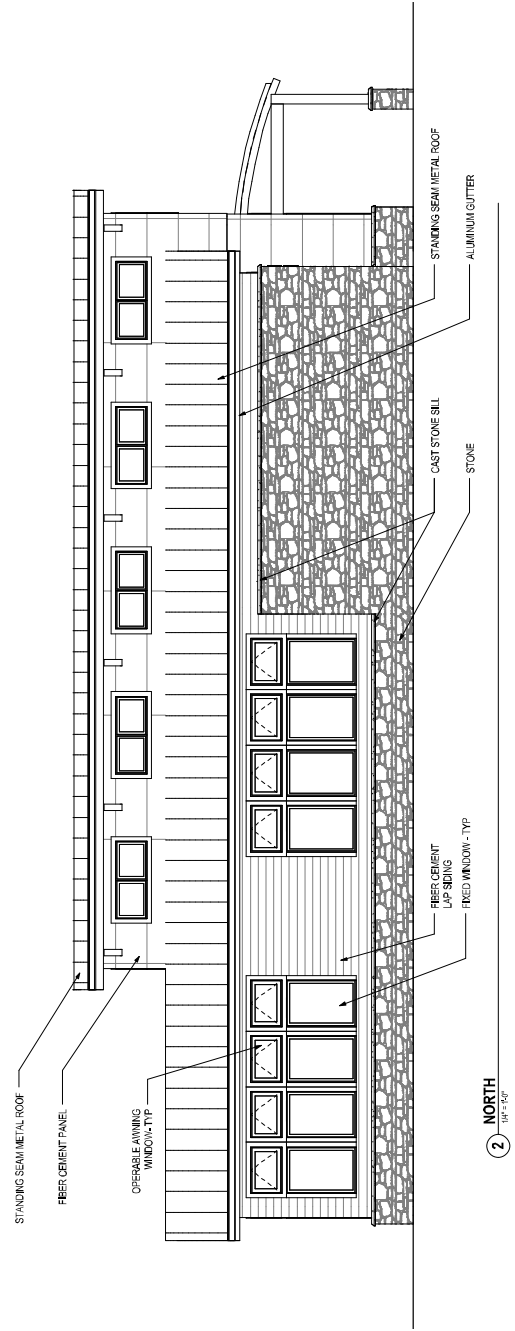
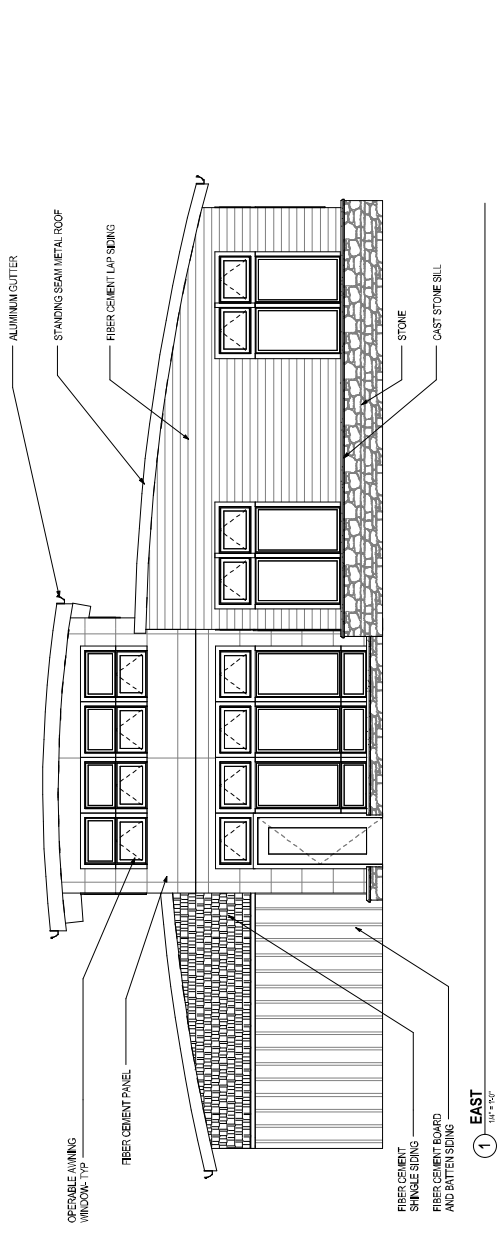


1 FIRST FLOOR PLAN  
1/4" = 1'-0"

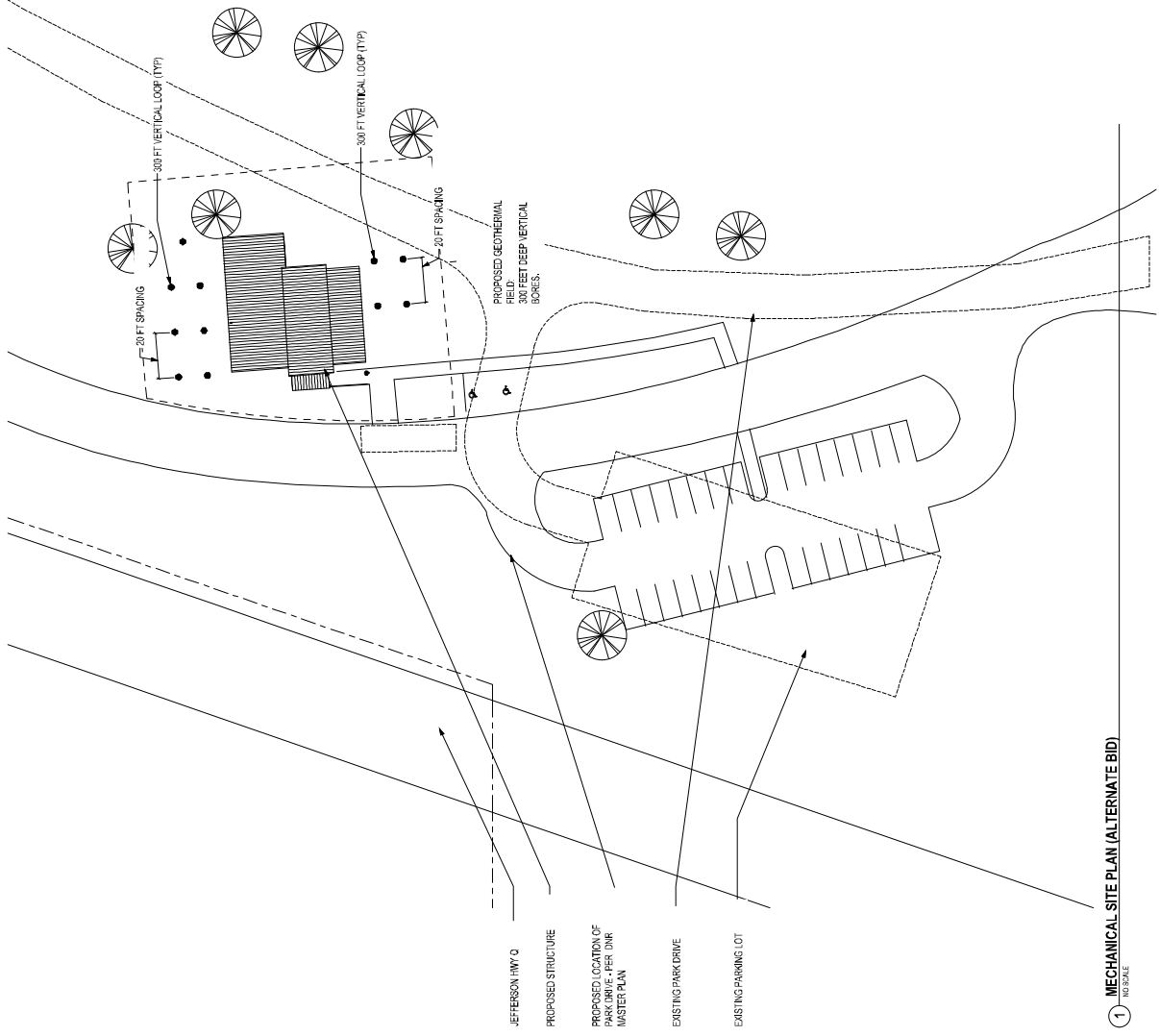
## FRIENDS OF AZTALAN STATE PARK: VISITOR CENTER PRELIMINARY DESIGN



# FRIENDS OF AZTALAN STATE PARK: VISITOR CENTER PRELIMINARY DESIGN

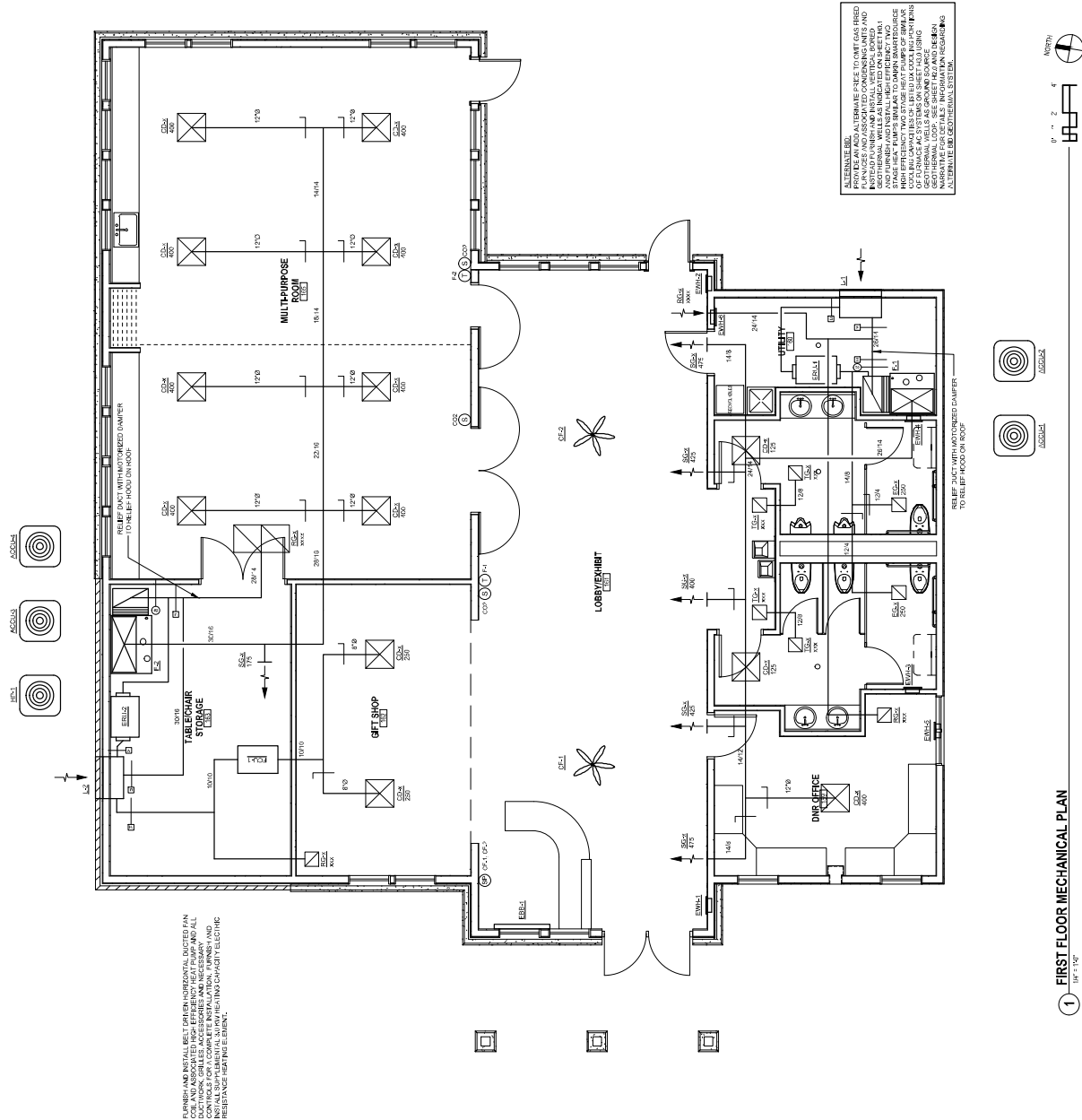


# FRIENDS OF AZTALAN STATE PARK: VISITOR CENTER PRELIMINARY DESIGN



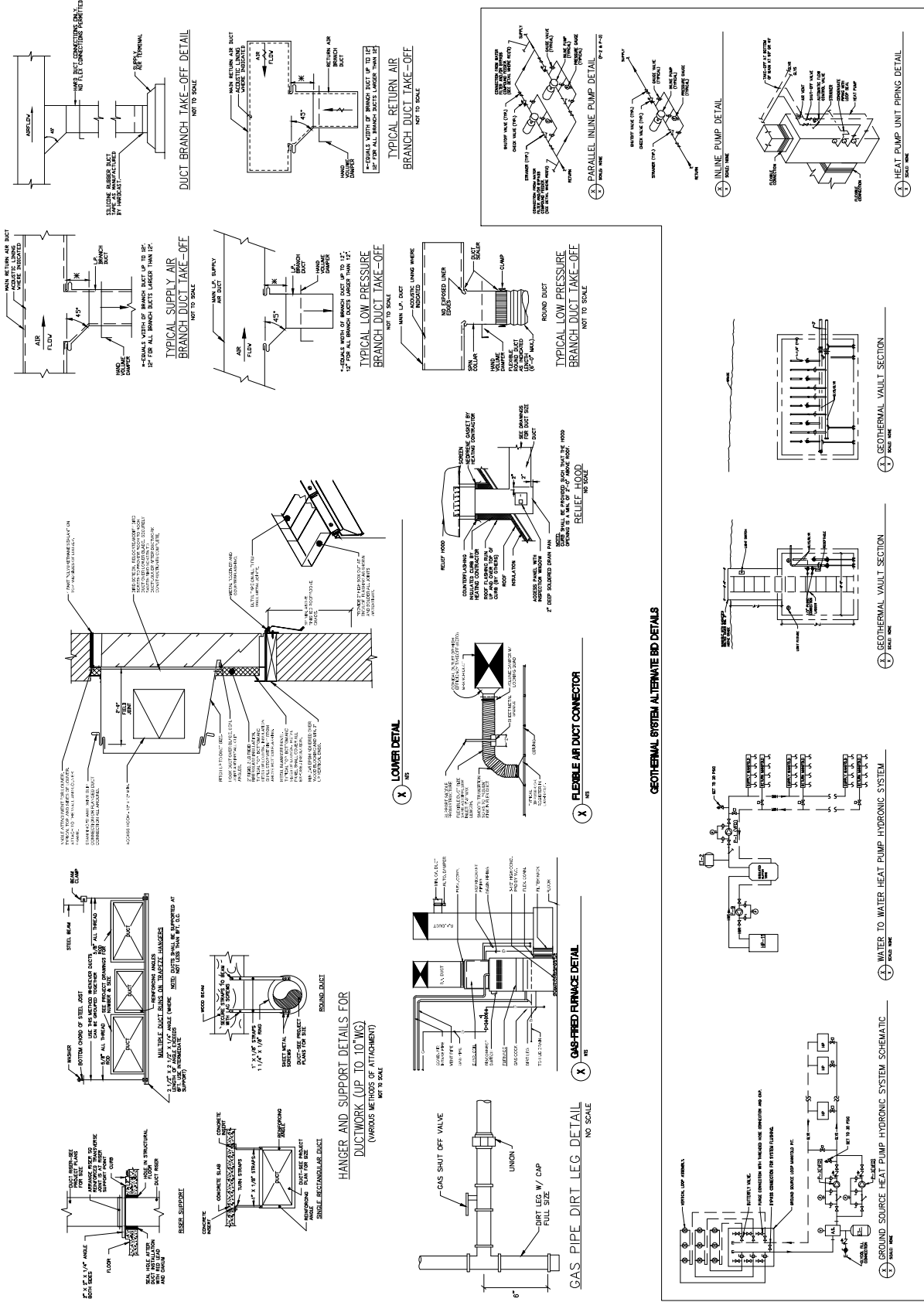


PRELIMINARY DESIGN - APRIL 10, 2015 - NOT FOR CONSTRUCTION





PRELIMINARY DESIGN - APRIL 10, 2015- NOT FOR CONSTRUCTION









PRELIMINARY DESIGN - APRIL 10, 2015- NOT FOR CONSTRUCTION

FRIENDS OF  
AZTALAN STATE  
PARK -VISITOR  
CENTER  
AZTALAN, WI

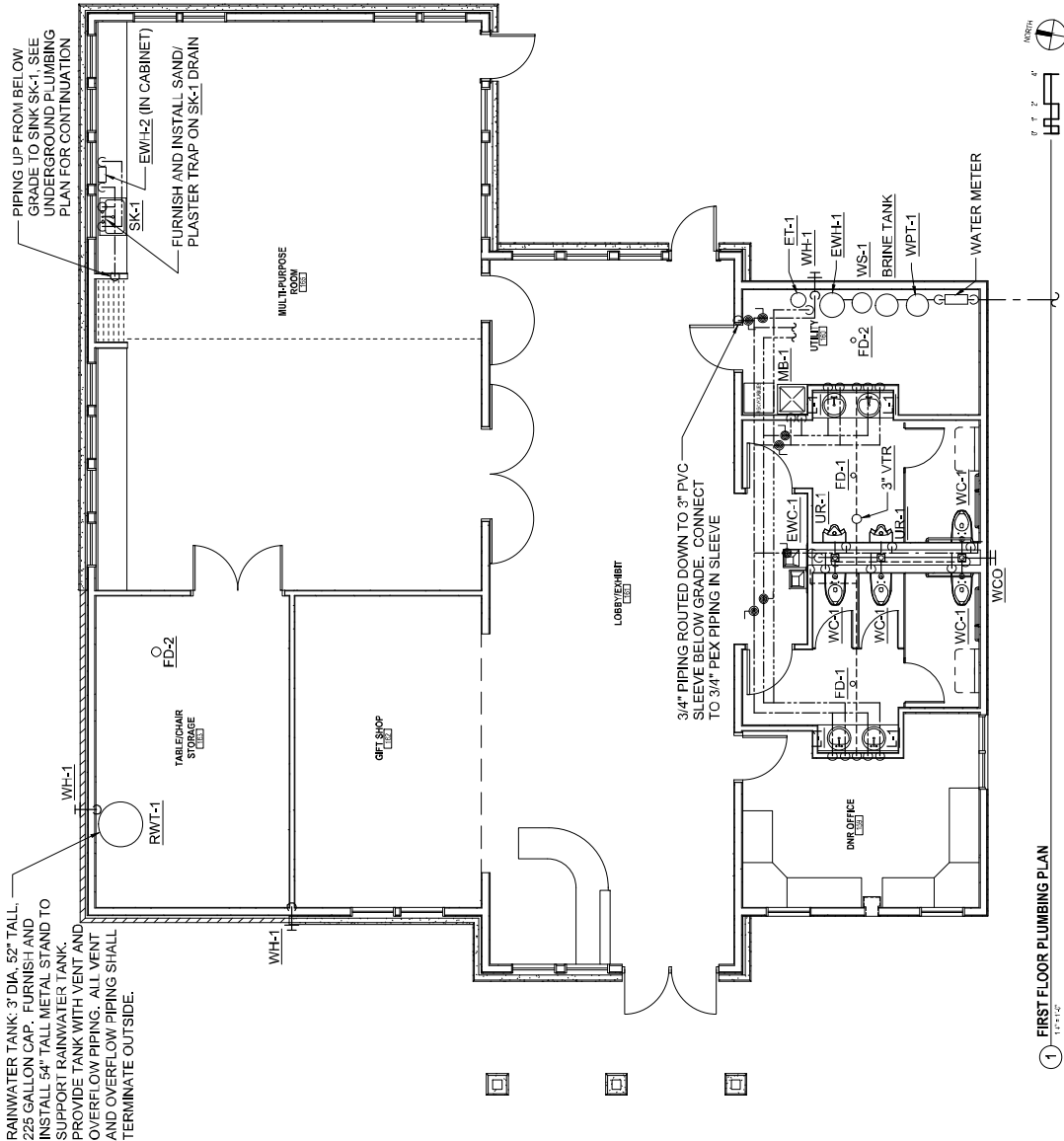
DATE OF ISSUE: APRIL 10, 2015
REVISIONS:

PROJECT # 140388

FIRST FLOOR  
PLUMBING PLAN



P2.0



### PLUMBING FIXTURE SCHEDULE

[illegible]

WH-1	<p>NOSE, BIRD, EXTERIOR, PREFLEXES, AUTORANAGING VACUUM BREAKER, BRASS BODY, CHROME PLATED FACE, WALL CLAMP 3/4" WALL HOSE THREAD, LOSE-EXPRESSION</p> <p>ACCEPTABLE MANUFACTURERS: WOODCROFT 2, JUMR 2, L310, WADE 8620</p> <p>THERMAL EXPANSION TANK WESSELLS MODEL 25 TX</p>
TD-1	<p>FLOOR DRAIN, 6" DIA, CHROME PLATED BRONZE ADJUSTABLE TOP, CAST IRON BODY, THREADED</p> <p>ACCEPTABLE MANUFACTURERS: SMITH 2000, JUMR 2015, WADE W.100</p>
TD-2	<p>FLOOR DRAIN, 9" DIA, CHROME PLATED BRONZE ADJUSTABLE TOP, ACID RESISTING EPOXY COATED CAST IRON BODY, THREADED LASHING COLLAR, 7" OUTLET.</p> <p>ACCEPTABLE MANUFACTURERS: SMITH 2000, JUMR 2250, WADE W-100</p>
MO-1	<p>WALL CLEANOUT, BODY AND PLUGS SHALL BE OF SAME MATERIAL AS PIPE WITH ROUND STAINLESS STEEL COVER PLATE AND CENTER SCREW INTO PLUGS.</p>
MO-2	<p>FLOOR CLEANOUT, ROUND, NICKEL BRONZE ADJUSTABLE SCREWED SECURED TOP, CAST IRON BODY AND PLUGS, OUTLET SIZE SHALL MATCH WALL SIZE. CO" SHALL BE CAST IN TOP</p> <p>ACCEPTABLE MANUFACTURERS: SMITH 4020, JUMR, WADE</p>

W-1	<p>(90°F) WATER, RESIST ASHRAE 90.1 EFFICIENCY STANDARDS, 21 GPM RECOVERY CAPACITY, 100 GPM FLOW, 19.5 US GALLON STORAGE CAPACITY, DUAL 4.5 KW HEATING ELEMENTS FOR NON-SIMULTANEOUS OPERATION</p> <p>PLUMBING MATERIALS: BRASS/POUR WHITE, RGC, LOCHINVAR</p>
W-2	<p>ELECTRIC DRAINAGE, WATER, 50 GPM, TEMPERATURE RANGE 0 TO 5 GPM WATER FLOW, 200 VOLT, SINGLE PHASE, ELECTRIC POWER, 4.5 KW HEATING ELEMENT</p>
W-3	<p>WATER SPLITTER, MAX. CONTINUOUS FLOW RATE 35 GPM, 4.5 KW GRAIN CAPACITY AT MEDIUM SALT LEVEL, FURNISH AND INSTALL TREND, ACCEPTABLE MANUFACTURERS: HELLERBACK, CULLIGAN</p>

FRIENDS OF  
AZTALAN STATE  
PARK - VISITOR  
CENTER  
AZTALAN, WI

PRELIMINARY DESIGN - APRIL 10, 2015 - NOT FOR CONSTRUCTION

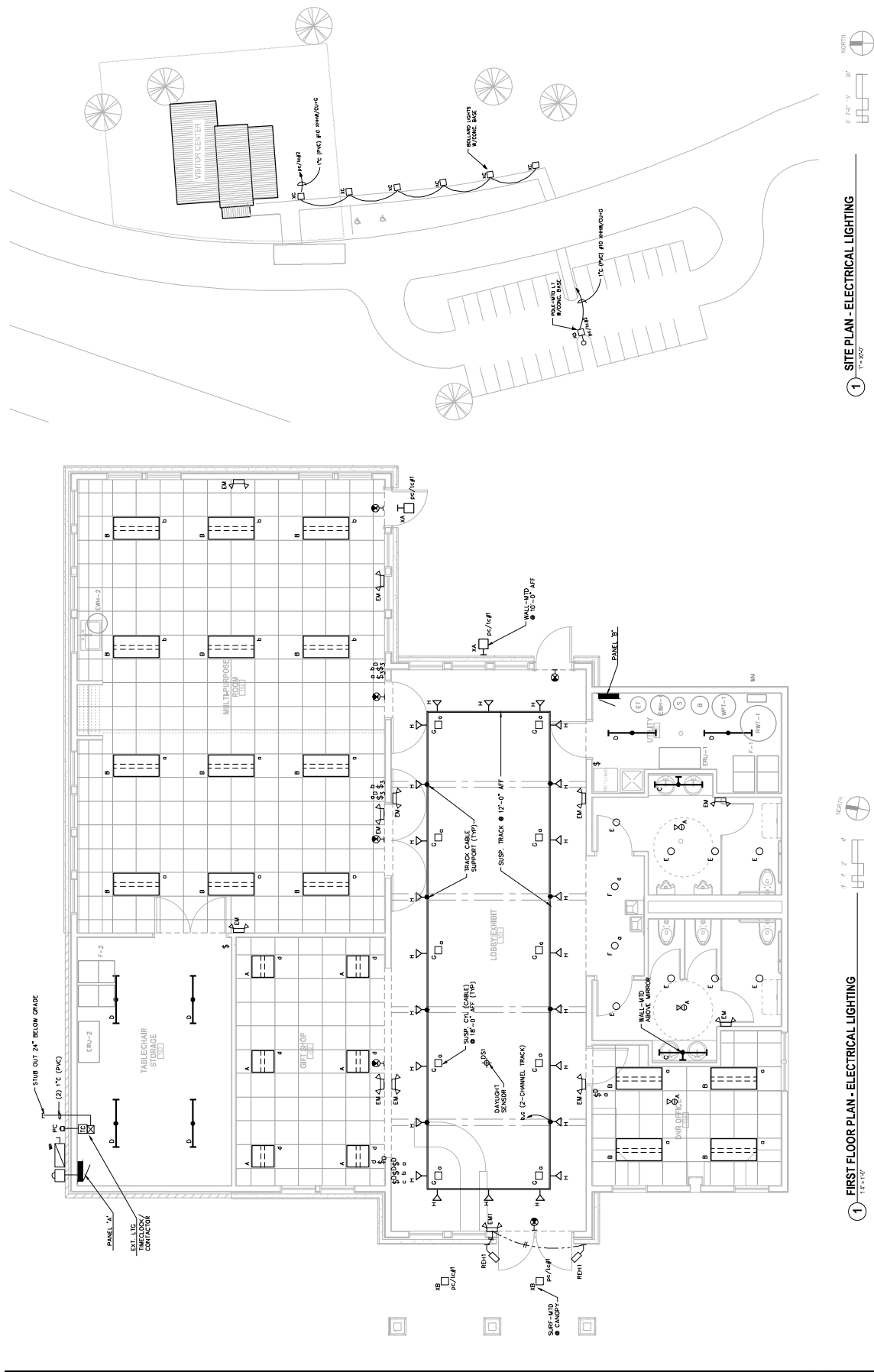
DATE OF ISSUE: APRIL 10, 2015

REVISIONS:

PROJECT # 140

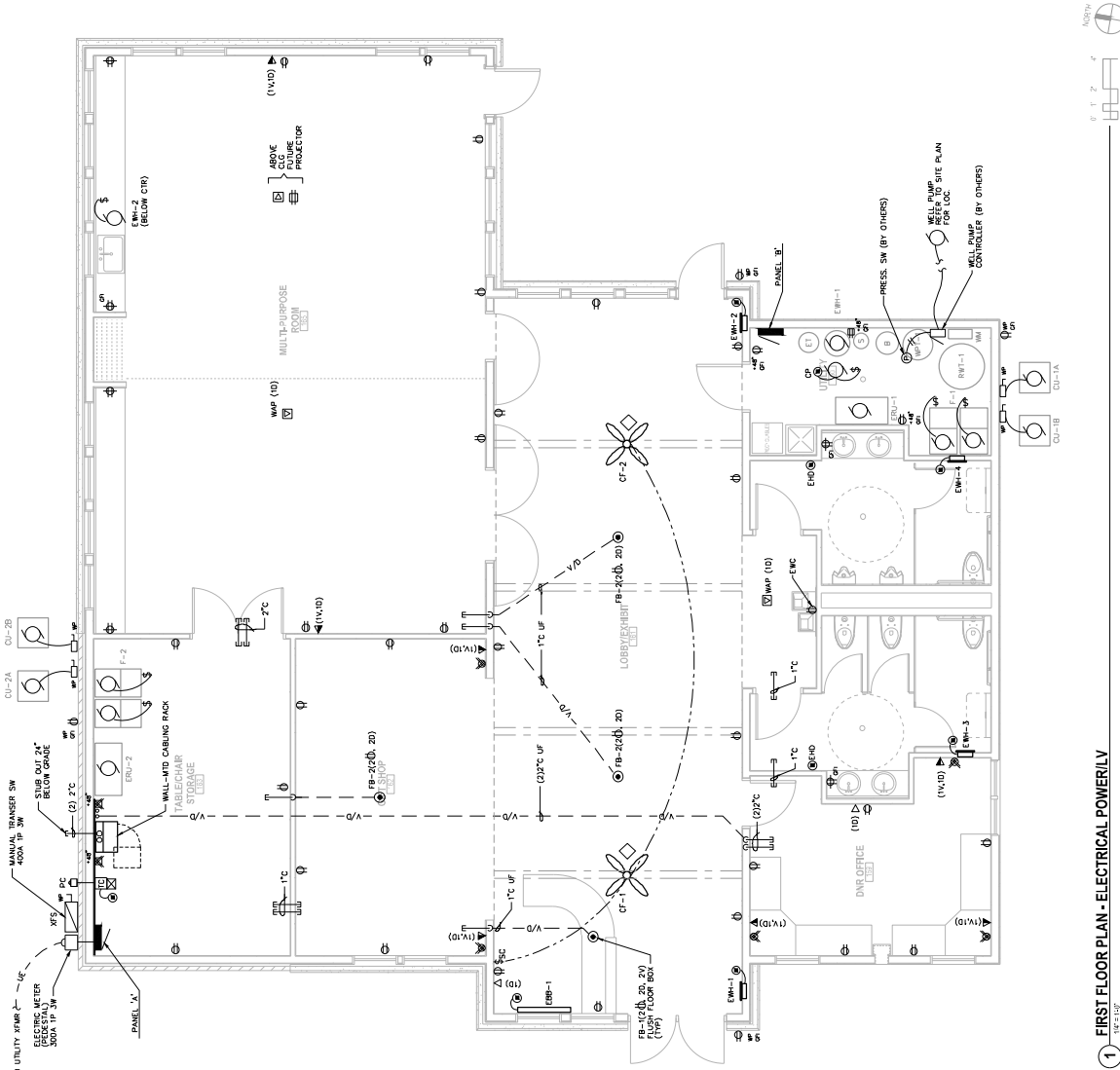
## PLUMBING DETAILS AND SCHEDULE

# P5.0



**1** FIRST FLOOR PLAN - ELECTRICAL LIGHTING

**1** SITE PLAN - ELECTRICAL LIGHTING





### **ELECTRICAL MOTOR/EQUIPMENT SCHEDULE**

[illegible]

## LIGHTING FIXTURE SCHEDULE

TAG	LINE	W/TYPE	DESCRIPTION	ROUTING	7-FIGURE W/TYPE REFERENCE	BU-115 W/TYPE REFERENCE	REMARKS
A	10	20	W/TYPE	555/500	UT/NOVA	(1) 10-20 100V/500	
B	10	20	W/TYPE	555/500	UT/NOVA	(2) 10-20 100V/500	
C	10	20	W/TYPE	555/500	UT/NOVA	(3) 10-20 100V/500	
D	10	20	W/TYPE	555/500	UT/NOVA	(4) 10-20 100V/500	
E	10	20	W/TYPE	555/500	UT/NOVA	(5) 10-20 100V/500	
F	10	20	W/TYPE	555/500	UT/NOVA	(6) 10-20 100V/500	
G	10	20	W/TYPE	555/500	UT/NOVA	(7) 10-20 100V/500	
H	10	20	W/TYPE	555/500	UT/NOVA	(8) 10-20 100V/500	
I	10	20	W/TYPE	555/500	UT/NOVA	(9) 10-20 100V/500	
J	10	20	W/TYPE	555/500	UT/NOVA	(10) 10-20 100V/500	
K	10	20	W/TYPE	555/500	UT/NOVA	(11) 10-20 100V/500	
L	10	20	W/TYPE	555/500	UT/NOVA	(12) 10-20 100V/500	
M	10	20	W/TYPE	555/500	UT/NOVA	(13) 10-20 100V/500	
N	10	20	W/TYPE	555/500	UT/NOVA	(14) 10-20 100V/500	
O	10	20	W/TYPE	555/500	UT/NOVA	(15) 10-20 100V/500	
P	10	20	W/TYPE	555/500	UT/NOVA	(16) 10-20 100V/500	
Q	10	20	W/TYPE	555/500	UT/NOVA	(17) 10-20 100V/500	
R	10	20	W/TYPE	555/500	UT/NOVA	(18) 10-20 100V/500	
S	10	20	W/TYPE	555/500	UT/NOVA	(19) 10-20 100V/500	
T	10	20	W/TYPE	555/500	UT/NOVA	(20) 10-20 100V/500	
U	10	20	W/TYPE	555/500	UT/NOVA	(21) 10-20 100V/500	
V	10	20	W/TYPE	555/500	UT/NOVA	(22) 10-20 100V/500	
W	10	20	W/TYPE	555/500	UT/NOVA	(23) 10-20 100V/500	
X	10	20	W/TYPE	555/500	UT/NOVA	(24) 10-20 100V/500	
Y	10	20	W/TYPE	555/500	UT/NOVA	(25) 10-20 100V/500	
Z	10	20	W/TYPE	555/500	UT/NOVA	(26) 10-20 100V/500	
AA	10	20	W/TYPE	555/500	UT/NOVA	(27) 10-20 100V/500	
AB	10	20	W/TYPE	555/500	UT/NOVA	(28) 10-20 100V/500	
AC	10	20	W/TYPE	555/500	UT/NOVA	(29) 10-20 100V/500	
AD	10	20	W/TYPE	555/500	UT/NOVA	(30) 10-20 100V/500	
AE	10	20	W/TYPE	555/500	UT/NOVA	(31) 10-20 100V/500	
AF	10	20	W/TYPE	555/500	UT/NOVA	(32) 10-20 100V/500	
AG	10	20	W/TYPE	555/500	UT/NOVA	(33) 10-20 100V/500	
AH	10	20	W/TYPE	555/500	UT/NOVA	(34) 10-20 100V/500	
AI	10	20	W/TYPE	555/500	UT/NOVA	(35) 10-20 100V/500	
AJ	10	20	W/TYPE	555/500	UT/NOVA	(36) 10-20 100V/500	
AK	10	20	W/TYPE	555/500	UT/NOVA	(37) 10-20 100V/500	
AL	10	20	W/TYPE	555/500	UT/NOVA	(38) 10-20 100V/500	
AM	10	20	W/TYPE	555/500	UT/NOVA	(39) 10-20 100V/500	
AN	10	20	W/TYPE	555/500	UT/NOVA	(40) 10-20 100V/500	
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AP	10	20	W/TYPE	555/500	UT/NOVA	(42) 10-20 100V/500	
AQ	10	20	W/TYPE	555/500	UT/NOVA	(43) 10-20 100V/500	
AR	10	20	W/TYPE	555/500	UT/NOVA	(44) 10-20 100V/500	
AS	10	20	W/TYPE	555/500	UT/NOVA	(45) 10-20 100V/500	
AT	10	20	W/TYPE	555/500	UT/NOVA	(46) 10-20 100V/500	
AU	10	20	W/TYPE	555/500	UT/NOVA	(47) 10-20 100V/500	
AV	10	20	W/TYPE	555/500	UT/NOVA	(48) 10-20 100V/500	
AW	10	20	W/TYPE	555/500	UT/NOVA	(49) 10-20 100V/500	
AX	10	20	W/TYPE	555/500	UT/NOVA	(50) 10-20 100V/500	
AY	10	20	W/TYPE	555/500	UT/NOVA	(51) 10-20 100V/500	
AZ	10	20	W/TYPE	555/500	UT/NOVA	(52) 10-20 100V/500	
BA	10	20	W/TYPE	555/500	UT/NOVA	(53) 10-20 100V/500	
BB	10	20	W/TYPE	555/500	UT/NOVA	(54) 10-20 100V/500	
BC	10	20	W/TYPE	555/500	UT/NOVA	(55) 10-20 100V/500	
BD	10	20	W/TYPE	555/500	UT/NOVA	(56) 10-20 100V/500	
BE	10	20	W/TYPE	555/500	UT/NOVA	(57) 10-20 100V/500	
BF	10	20	W/TYPE	555/500	UT/NOVA	(58) 10-20 100V/500	
BG	10	20	W/TYPE	555/500	UT/NOVA	(59) 10-20 100V/500	
BH	10	20	W/TYPE	555/500	UT/NOVA	(60) 10-20 100V/500	
BI	10	20	W/TYPE	555/500	UT/NOVA	(61) 10-20 100V/500	
BJ	10	20	W/TYPE	555/500	UT/NOVA	(62) 10-20 100V/500	
BK	10	20	W/TYPE	555/500	UT/NOVA	(63) 10-20 100V/500	
BL	10	20	W/TYPE	555/500	UT/NOVA	(64) 10-20 100V/500	
BM	10	20	W/TYPE	555/500	UT/NOVA	(65) 10-20 100V/500	
BN	10	20	W/TYPE	555/500	UT/NOVA	(66) 10-20 100V/500	
BO	10	20	W/TYPE	555/500	UT/NOVA	(67) 10-20 100V/500	
BP	10	20	W/TYPE	555/500	UT/NOVA	(68) 10-20 100V/500	
BQ	10	20	W/TYPE	555/500	UT/NOVA	(69) 10-20 100V/500	
BR	10	20	W/TYPE	555/500	UT/NOVA	(70) 10-20 100V/500	
BS	10	20	W/TYPE	555/500	UT/NOVA	(71) 10-20 100V/500	
BT	10	20	W/TYPE	555/500	UT/NOVA	(72) 10-20 100V/500	
BU	10	20	W/TYPE	555/500	UT/NOVA	(73) 10-20 100V/500	
BV	10	20	W/TYPE	555/500	UT/NOVA	(74) 10-20 100V/500	
BW	10	20	W/TYPE	555/500	UT/NOVA	(75) 10-20 100V/500	
BX	10	20	W/TYPE	555/500	UT/NOVA	(76) 10-20 100V/500	
BY	10	20	W/TYPE	555/500	UT/NOVA	(77) 10-20 100V/500	
BZ	10	20	W/TYPE	555/500	UT/NOVA	(78) 10-20 100V/500	
CA	10	20	W/TYPE	555/500	UT/NOVA	(79) 10-20 100V/500	
CB	10	20	W/TYPE	555/500	UT/NOVA	(80) 10-20 100V/500	
CC	10	20	W/TYPE	555/500	UT/NOVA	(81) 10-20 100V/500	
CD	10	20	W/TYPE	555/500	UT/NOVA	(82) 10-20 100V/500	
CE	10	20	W/TYPE	555/500	UT/NOVA	(83) 10-20 100V/500	
CF	10	20	W/TYPE	555/500	UT/NOVA	(84) 10-20 100V/500	
CG	10	20	W/TYPE	555/500	UT/NOVA	(85) 10-20 100V/500	
CH	10	20	W/TYPE	555/500	UT/NOVA	(86) 10-20 100V/500	
CI	10	20	W/TYPE	555/500	UT/NOVA	(87) 10-20 100V/500	
CJ	10	20	W/TYPE	555/500	UT/NOVA	(88) 10-20 100V/500	
CK	10	20	W/TYPE	555/500	UT/NOVA	(89) 10-20 100V/500	
CL	10	20	W/TYPE	555/500	UT/NOVA	(90) 10-20 100V/500	
CM	10	20	W/TYPE	555/500	UT/NOVA	(91) 10-20 100V/500	
CN	10	20	W/TYPE	555/500	UT/NOVA	(92) 10-20 100V/500	
CO	10	20	W/TYPE	555/500	UT/NOVA	(93) 10-20 100V/500	
CP	10	20	W/TYPE	555/500	UT/NOVA	(94) 10-20 100V/500	
CQ	10	20	W/TYPE	555/500	UT/NOVA	(95) 10-20 100V/500	
CR	10	20	W/TYPE	555/500	UT/NOVA	(96) 10-20 100V/500	
CS	10	20	W/TYPE	555/500	UT/NOVA	(97) 10-20 100V/500	
CT	10	20	W/TYPE	555/500	UT/NOVA	(98) 10-20 100V/500	
CU	10	20	W/TYPE	555/500	UT/NOVA	(99) 10-20 100V/500	
CV	10	20	W/TYPE	555/500	UT/NOVA	(100) 10-20 100V/500	
CW	10	20	W/TYPE	555/500	UT/NOVA	(101) 10-20 100V/500	
CX	10	20	W/TYPE	555/500	UT/NOVA	(102) 10-20 100V/500	
CY	10	20	W/TYPE	555/500	UT/NOVA	(103) 10-20 100V/500	
CZ	10	20	W/TYPE	555/500	UT/NOVA	(104) 10-20 100V/500	
DA	10	20	W/TYPE	555/500	UT/NOVA	(105) 10-20 100V/500	
DB	10	20	W/TYPE	555/500	UT/NOVA	(106) 10-20 100V/500	
DC	10	20	W/TYPE	555/500	UT/NOVA	(107) 10-20 100V/500	
DD	10	20	W/TYPE	555/500	UT/NOVA	(108) 10-20 100V/500	
DE	10	20	W/TYPE	555/500	UT/NOVA	(109) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(110) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(111) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(112) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(113) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(114) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(115) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(116) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(117) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(118) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(119) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(120) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(121) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(122) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(123) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(124) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(125) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(126) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(127) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(128) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(129) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(130) 10-20 100V/500	
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DF	10	20	W/TYPE	555/500	UT/NOVA	(132) 10-20 100V/500	
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DF	10	20	W/TYPE	555/500	UT/NOVA	(137) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(138) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(139) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(140) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(141) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(142) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(143) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(144) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(145) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(146) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(147) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(148) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(149) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(150) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(151) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(152) 10-20 100V/500	
DF	10	20	W/TYPE	555/500	UT/NOVA	(153) 10-20 100V/500	
DF	10	20	W/TYPE	555/500			

## **ELECTRICAL SYMBOL SCHEDULE**

[illegible]

**GENERAL ELECTRICAL SCHEDULE NOTES:**

MANUFACTURER NAMES AND CATALOG NUMBERS ARE INCLUDED AS A BASIS OF DESIGN FOR QUALITY AND PERFORMANCE ONLY. EQUIPMENT MANUFACTURED BY OTHERS WILL BE EQUALLY ACCEPTABLE PROVIDED THEY MEET OR EXCEED THE SPECIFICATIONS.

## FLOOR BOX SCHEDULE

[illegible]

## DAYLIGHT SENSOR SCHEDULE

SYMBOL	VOLTING	VOLTAGE	RATED CURRENT	TYPE	MPFR. & MODEL	REMARKS
0-01	REG3520/ L/C	1.20 VAC	800 WATT	ON/OFF PHOTOCELL	SENSOR SWITCH DAW-PC	LINE VOLTAGE
REMARKS						

## OCCUPANCY SENSOR SCHEDULE

[illegible]

TELEPHONE OUTLET IN FLOOR  
-FLUSH MOUNTED

[illegible]



**JUNE 15, 2015**

**FRIENDS OF AZTALAN STATE PARK  
VISITOR CENTER  
Lake Mills, Wisconsin  
Dimension IV Madison Project No. 14098**

Architect: Dimension IV – Madison, LLC  
6515 Grand Teton Plaza, Suite 120  
Madison, Wisconsin 53719

Project Description:

In general, the project is a new 3,150 square foot visitor's center that contains a main lobby/exhibit space, a gift shop, multi-purpose room, public restrooms, and offices. The building will be constructed on land within the boundaries of Aztalan State Park. The building will consist of a single slab-on-grade level and wood framed construction. The building will be divided into three rectangular volumes with curved roofs. The Department of Natural Resources will be doing a separate but coordinated project that will rework the park's roads and parking for the new visitor's center. This project's scope is limited to the building itself and the immediate site work, including a terrace of approximately 800-1,000 square feet.

The design and construction effort for the Visitor Center is being led by the Friends of Aztalan State Park Group which intends to gift the completed building, after occupancy, to the State of Wisconsin. As a result, DOA/DFD standards must be met in the design and construction of the facility.

The entire site is designated as a National Landmark and listed on the National Register of Historic places. Supervision by an archaeologist will be required during excavation activities.

**Outline Specifications**

Sustainable Design Specifications

Referenced sections are from the Wisconsin DOA, Division of State Facilities Sustainable Facilities Standards.

- |           |  |
|-----------|--|
| MR C2.1:  | Construction Waste Management – Divert From Land Fill: Contractor to develop and implement a waste management plan and goal (%) for recycling and/or salvaging construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout.  |
| MR C.3.1: | Resource Reuse: Contractor to develop and implement a plan and goal of up to 10% for reuse of building materials and products.   |
| MR C4.1:  | Recycled Content: Contractor to procure materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes 10-20% of the total value of the materials in the project. Materials for the new construction will be specified to include recycled content wherever practicable. |
| MR C5.1:  | Regional Materials: Contractor to procure and use a minimum of 20% of building materials and products that have been extracted and manufactured regionally within a radius of 500 miles.   |

- MR C6: Renewable Materials: Contractor to procure and use renewable building materials and products (made from plants that are typically harvested within a ten-year cycle or shorter) for 5% of the total value of all building materials and products used in the project.
- MR W1: Durable Building: Contractor to develop and implement a durable building plan, in accordance with the principles in *CSA S478-95 (R2001) Guideline on Durability in Buildings*, for the components within the scope of the Guideline, for the construction and preoccupancy phases of the building.
- EQ P2: Environmental Tobacco Smoke (ETS) Control: Zero exposure of building occupants and systems to environmental tobacco smoke.
- EQ C3.1: Construction IAQ Management Plan During Construction: Contractor to develop and implement an IAQ management plan for the construction and preoccupancy phases of the building.
- EQ C3.2: Construction IAQ Management Plan Before Occupancy: Contractor to develop and implement an IAQ management plan for the preoccupancy phase of the building.

#### Site Work Specifications

- Earthwork: Excavation, site clearing, rough grading, imported soils as required, and fill, backfilling, compaction and erosion controls. Selected tree and shrub removal.
- Clearing: Clearing and stockpiling of topsoil.
- Paving: Concrete sidewalks, pervious pavers for terraced area.
- Utilities: Water to be provided by an on-site domestic water well. Septic system will be required; a drain field system is preferred. On-site propane tank may be required. See mechanical, electrical and plumbing specifications.
- Landscaping: Topsoil, final grading, grasses, trees, shrubs, and other plantings.

#### Structure and Building Envelope Specifications

- Foundation: Concrete spread footings and perimeter concrete wall foundation.
- Floor: Reinforced concrete slab-on-grade at lower level; no wax polished concrete. Plywood subflooring.
- Building Structure: Wood framed. Center lobby roof to have exposed glulam beam/trusses; north and south wings to have conventional trusses.
- Exterior Wall: Wood stud wall framing. OSB sheathing; glass-mat gypsum wall sheathing as required for non-combustible sheathing. Stone veneer base and fiber cement panels and lap siding above. Sealant at all joints.
- Insulation: Exterior wall minimum of 1" continuous insulation in addition to stud cavities being filled with R-19 batt insulation. Lobby roof to have continuous insulation entirely

above roof deck with minimum R-value of 30. Minimum of R-50 blown cellulose insulation in attic spaces above the north and south wings.

Roofing:	Standing seam metal roof.
Gutters & Downspouts:	Aluminum; to drain to in-ground storage tank.
Soffit and Trim:	Prefinished metal.
Exterior Windows:	Fixed and operable, metal clad wood frame with low-e triple pane glazing. Operable windows to have blinds; fixed windows to have roller shades. Solid surface window sills.
Exterior Doors:	Insulated hollow metal doors and frames with tempered full glass lites. Aluminum-framed entrance and storefront. Power-assist door operators at main entrance door.

#### Interior Specifications

Wall Partitions:	Wood stud framing. Gypsum board, type X 5/8 inch, abuse-resistant, water-resistant. Moveable wall partition in multipurpose room of durable material with high acoustical performance values.
Interior Doors:	Typically flush, solid core, wood veneer in metal frames. Select doors, including main entry and multipurpose room doors, are to receive electric access controls for programmable access. Gift shop to receive rolling security grille.
Rough Carpentry:	Framing, furring, blocking.
Finish Carpentry:	Hardwood trim, window casing and base.
Wall Finish:	Painted gypsum board.
Tile:	Ceramic tile floors and walls in bathrooms.
Toilet Partitions:	Vandal resistant, solid surface.
Ceilings:	2 x 2 acoustical tile and painted gypsum board in bathrooms.
Painting:	Gypsum board only.
Carpet Tile:	Commercial grade; 24 oz.; 100% solution dyed.
Specialties:	Market boards, bulletin boards, wall base, wall and corner guards, interior and exterior signage, fire extinguishers, toilet accessories, baby changing station.
Casework:	Wood and/or plastic laminate cabinets, solid surface countertops. Solid surface countertop at reception counter. Solid surface bathroom vanities with integral sinks.
Floor Drains:	Each restroom and utility space.

Plumbing/Fire Protection Specifications

Specifications are separate from this Outline Specification.

Heating, Ventilating, and Air-Conditioning Specifications

Specifications are separate from this Outline Specification.

Electrical Specifications

Cabling: Data and voice cabling to be Cat 6.

All other Electrical Specifications are separate from this Outline Specification.

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**SECTION 22 05 00**  
**COMMON WORK RESULTS FOR PLUMBING**

**PART 1 - GENERAL**

**SCOPE**

This section includes information common to two or more technical plumbing specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Lead Free Requirements
- Quality Assurance
- Protection of Finished Surfaces
- Sleeves and Openings
- Sealing and Fire Stopping
- Submittals
- Codes
- Certificates and Inspections
- Operating and Maintenance Data
- Record Drawings

**PART 2 - PRODUCTS**

- Identification
- Sealing and Fire Stopping
- Bedding and Backfill

**PART 3 - EXECUTION**

- Excavation and Backfill
- Sheeting, Shoring and Bracing
- Dewatering
- Surface Repair
- Concrete Work
- Cutting and Patching
- Building Access
- Equipment Access
- Coordination
- Identification
- Lubrication
- Sleeves and Openings
- Sealing and Firestopping

**RELATED WORK**

Section 07 84 00 – Fire Stopping

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

This section applies to all Division 22 00 00 sections of plumbing.

**LEAD FREE REQUIREMENTS**

All materials that contact potable water shall be lead free. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content  $\leq 0.25\%$  per the Federal Safe Drinking Water Act as amended January 4th 2011 Section 1417.

This requirement applies to all of the subsequent Plumbing Specification Sections and Plumbing Drawings and supersedes any part or model number that may conflict with this requirement.

## **QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC - General Conditions of the Contract, Equals and Substitutions.

All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

## **PROTECTION OF FINISHED SURFACES**

Refer to Division 1, General Requirements, Protection of Finished Surfaces.

## **SLEEVES AND OPENINGS**

Refer to Division 1, General Requirements, Sleeves and Openings.

## **SEALING AND FIRESTOPPING**

Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 Fire Stopping.

## **CODES**

Comply with requirements of Wisconsin Administrative Code.

## **CERTIFICATES AND INSPECTIONS**

Refer also to Division 1, General Conditions, Permits, Regulations, Utilities and Taxes.

Obtain and pay for all required State installation inspections except those provided by the Architect/Engineer. Deliver the originals of inspection certificates and test records to the Owner's Project Representative. Include copies of the certificates and test records in the Operating and Maintenance Instructions.

## **SUBMITTALS**

Refer to Division 1, General Conditions, Submittals.

Shop drawing submittals are to be bound, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.

The specific items that will be required for submittals shall be coordinated with the General Prime Contractor for inclusion in the project submittal log.

Submit sufficient quantities of data sheets and shop drawings to allow the following distribution:

*	Operating and Maintenance Manuals	2 copies
*	Architect/Engineer	1 copy

## **OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.



In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. Records of tests performed to certify compliance with system requirements
2. Manufacturer's wiring diagrams for electrically powered equipment
3. Certificates of inspection by regulatory agencies
4. Valve schedules
5. Lubrication instructions, including list/frequency of lubrication
6. Parts lists for fixtures, equipment, valves and specialties.
7. Manufacturers installation, operation and maintenance recommendations for fixtures, equipment, valves and specialties.
8. Additional information as indicated in the technical specification sections

#### **TRAINING OF OWNER PERSONNEL**

Instruct user agency personnel in the proper operation and maintenance of systems and equipment provided as part of this project. Demonstrate startup, operation and shutdown procedures for all equipment. All training to be during normal working hours.

#### **RECORD DRAWINGS**

Refer to Division 1, General Requirements, Record Drawings.

### **PART 2 - PRODUCTS**

#### **ACCESS PANELS AND DOORS**

##### **LAY-IN CEILINGS:**

Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Section 09500 are sufficient; no additional access provisions are required unless specifically indicated.

##### **IDENTIFICATION**

###### **ENGRAVED NAME PLATES:**

White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite Style EIP by EMED Co., or equal by W. H. Brady.

###### **ADHESIVE LABELS:**

Pressure-sensitive, adhesive backed, vinyl pipe markers with applicable labeling, 3/4" min. size for lettering and surrounding tape on both ends. With flow arrows on piping. Conforming to ANSI, ANSI and NFPA standards. Seton Opti-Code, MSI, Brady or approved equal. Clean piping before application.

###### **SNAP-AROUND PIPE MARKERS:**

One-piece, preformed, vinyl construction, snap-around or strap-around pipe markers with applicable labeling and flow direction arrows, 3/4" min. size for lettering. Provide nylon ties on each end of pipe markers. Equal to Seton Setmark.

###### **VALVE TAGS:**

Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains, brass "S" hooks or one piece nylon ties around the valve stem, available from EMED Co., Seton Name Plate Company, or W. H. Brady.

#### **BEDDING AND BACKFILL**

Bedding up to a point 12" inches above the top of the pipe shall be thoroughly compacted sand or crushed stone chips meeting the following gradations:

<u>Gradation for Bedding Sand</u>		<u>Gradation for Crushed Stone Chip Bedding</u>	
<u>Sieve Size</u>	<u>% Passing (by Wt)</u>	<u>Sieve Size</u>	<u>% Passing (by Wt)</u>
1 inch	100	1/2 inch	100

No. 16	45 - 80	No. 4	75 - 100
No. 200	2 - 10	No. 100	10 - 25

Backfill above the bedding in lawn areas shall be thoroughly compacted excavated material free of large stones, organic, perishable, and frozen materials.

Backfill above the bedding under existing and future utilities, paving, sidewalks, curbs, roads and buildings shall be granular materials, pit run sand, gravel, or crushed stone, free from large stones, organic, perishable, and frozen materials.

## **SEALING AND FIRE STOPPING**

### **FIRE AND/OR SMOKE RATED PENETRATIONS:**

Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 "Fire Stopping".

In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. The operating bolts of the mechanical type seal shall be accessible from the interior of the building.

At pipe penetrations of non-rated interior partitions, floors and exterior walls, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material

## **PART 3 - EXECUTION**

### **EXCAVATION AND BACKFILL**

Perform all excavation and backfill work necessary to accomplish indicated plumbing systems installation. Excavate to bottom of pipe and structure bedding, 4" in stable soils, 6" in rock or wet trenches and 8" in unstable soil. Finish bottoms of excavations to true, level surface.

Strip topsoil from area to be excavated, free from subsoil and debris, and store for later respreading.

At no time place excavated materials where they will impede surface drainage unless such drainage is being safely rerouted away from the excavation.

Excavate whatever materials are encountered as required to place at the elevations shown, all pipe, manholes, and other work. Remove debris and rubbish from excavations before placing bedding and backfill material.

Remove surplus excavated materials from site.

Verify the locations of any water, drainage, gas, sewer, electric, telephone or steam lines which may be encountered in the excavation. Underpin and support all lines. Cut off service connections encountered which are to be removed at the limits of the excavation and cap.

Provide and maintain all fencing, barricades, signs, warning lights, and/or other equipment necessary to keep all excavation pits and trenches and the entire subgrade area safe under all circumstances and at all times. No excavation shall be left unattended without adequate protection.

Elevations shown on the plans are subject to such revisions as may be necessary to fit field conditions. No adjustment in compensation will be made for adjustments up to two (2) feet above or below the grades indicated on the plans.

1 Install lines passing under foundations with minimum of 1-1/2 inch clearance to concrete and insure there is no  
2 disturbance of bearing soil.

3  
4 Bed pipe up to a point 12" above the top of the pipe. Take care during bedding, compaction and backfill not to  
5 disturb or damage piping.

6  
7 Mechanically compact bedding and backfill to prevent settlement. The initial compacted lift to not exceed 24"  
8 compacted to 95% density per Modified Proctor Test (ASTM D-1557). Subsequent lifts under pavements, curbs,  
9 walks and structures are not to exceed 12" and be compacted to 95% density per Modified Proctor Test. In all other  
10 areas where construction above the excavation is not anticipated within 2 years, mechanically compact backfill in  
11 lifts not exceeding 24" to 90% density per Modified Proctor Test. Route the equipment over each lift of the material  
12 so that the compaction equipment contacts all areas of the surface of the lift.

### 13 14 **SHEETING, SHORING AND BRACING**

15 Provide shoring, sheet piling and bracing in conformance with the Wisconsin Administrative Code to prevent earth  
16 from caving or washing into the excavation. Shore and underpin to properly support adjacent or adjoining  
17 structures. Abandon in place shoring, sheet piling and underpinning below the top of the pipe, or, if approved in  
18 advance by the engineer, maintained in place until other permanent support approved by the engineer is provided.

### 19 20 **DEWATERING**

21 Provide, operate and maintain all pumps and other equipment necessary to drain and keep all excavation pits,  
22 trenches and the entire subgrade area free from water under all circumstances. Obtain general permit from the  
23 Wisconsin Department of Natural Resources district office for discharge of construction dewatering effluent. Obtain  
24 well permit from the Wisconsin Department of Natural Resources district office for dewatering wells discharging  
25 more than 70 GPM. Comply with permit requirements.

### 26 27 **ROCK EXCAVATION**

28 Remove rock encountered in the excavation to a minimum dimension of six (6) inches outside the pipe. Rock  
29 excavation includes all hard, solid rock in ledges, bedded deposits and unstratified masses, all natural conglomerate  
30 deposits so firmly cemented as to present all the characteristics of solid rock; which material is so hard or so firmly  
31 cemented that in the opinion of the Engineer it is not practical to excavate and remove same with a power shovel  
32 except after thorough and continuous drilling and blasting. Rock excavation includes rock boulders of 1/2 cubic  
33 yard or more in volume.

34  
35 Rock excavation will be computed on the basis of the depth of rock removed and a trench width two (2) feet larger  
36 than the outside diameter of the pipe where one (1) pipe is laid in the trench and three (3) feet larger than the  
37 combined outside diameter where two (2) pipes are laid in the trench. Include 6" pipe and structure bedding in rock  
38 excavation. Include rock excavation shown on the plans in the Base Bid.

### 39 40 **CONCRETE WORK**

41 Plumbing Contractor to provide concrete house keeping pad for water heater.

42  
43 Plumbing related cast-in-place concrete on the exterior of the building to be provided by this Contractor in  
44 conformance with requirements of Division 3. This includes piping thrust restraints, pipe supports, cleanout cover  
45 pads, yard hydrant pads, etc.

### 46 47 **CUTTING AND PATCHING**

48 Refer to Division 1, General Requirements, Cutting and Patching.

### 49 50 **BUILDING ACCESS**

51 Arrange for the necessary openings in the building to allow for admittance or removal of all apparatus. When the  
52 building access was not previously arranged and must be provided by this contractor, restore any opening to its  
53 original condition after the apparatus has been brought into the building.

### 54 55 **EQUIPMENT ACCESS**

1 Install all piping, conduit and accessories to permit access to equipment for maintenance and service.

## 2 3 **COORDINATION**

4 Coordinate all work with other contractors prior to installation. Any work that is not coordinated and that interferes  
5 with other contractor's work shall be removed or relocated at the installing contractor's expense.

6  
7 Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

## 8 9 **IDENTIFICATION**

10 Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

11  
12 Identify interior piping not less than once every 30 feet, not less than once in each room, adjacent to each access  
13 door or panel, and on both side of the partition where accessible piping passes through walls or floors. Place flow  
14 directional arrows at each pipe identification location. Use one coat of black enamel against a light background or  
15 white enamel against a dark background.

16  
17 Identify all exterior buried piping for entire length with underground warning tape except for sewer piping which is  
18 routed in straight lines between manholes or cleanouts. Place tape 6"-12" below finished grade along entire length of  
19 pipe. Extend tape to surface at building entrances, meters, hydrants and valves. Where existing underground warning  
20 tape is broken during excavation, replace with new tape identifying appropriate service and securely spliced to ends  
21 of existing tape.

22  
23 Identify valves with brass tags bearing a system identification and a valve sequence number. Valve tags are not  
24 required at a terminal device unless the valves are greater than ten feet from the device, located in another room or  
25 not visible from device. Provide a typewritten valve schedule and pipe identification schedule indicating the valve  
26 number and the equipment or areas supplied by each valve and the symbols used for pipe identification; locate  
27 schedules in mechanical room and in each Operating and Maintenance manual. Schedule in mechanical room to be  
28 framed under clear plastic.

## 29 30 **LUBRICATION**

31 Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any  
32 reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions  
33 until the work is accepted by the Owner. Maintain a log of all lubricants used and frequency of lubrication; include  
34 this information in the Operating and Maintenance Manuals at the completion of the project.

## 35 36 **SLEEVES AND OPENINGS**

37 Pipe penetrations in new poured concrete horizontal construction requiring F and T rating: Form opening using hole  
38 form or core drill opening. Alternatively provide cast in place fire stopping devices/sleeves.

39  
40 Pipe penetrations in new poured concrete horizontal construction requiring F rating but no T rating: Same as pipe  
41 penetrations in new poured concrete construction requiring F and T ratings except that schedule 40 steel sleeves may  
42 also be used.

43  
44 Pipe penetrations in new poured concrete horizontal construction that do not require F or T ratings: Provide  
45 schedule 40 steel pipe sleeve, form opening using hole form or core drill opening.

46  
47 Where penetrating pipe or conduit weight is supported by floor, provide manufactured product or structural bearing  
48 collar designed to carry load.

## 49 50 **SEALING AND FIRE STOPPING**

### 51 **FIRE AND/OR SMOKE RATED PENETRATIONS:**

52 Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with  
53 section 07 84 00 Fire Stopping.

### 54 55 **NON-RATED PARTITIONS:**

1 At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of  
2 the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or  
3 insulation is completely blocked.  
4  
5  
6

END OF SECTION



**SECTION 22 05 14**  
**PLUMBING SPECIALTIES**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for floor drains, roof drains, cleanouts, backflow preventers, water hammer arrestors and other miscellaneous plumbing specialties.

**PART 1 - GENERAL**

Scope  
Related Documents  
Reference  
Quality Assurance  
Shop Drawings  
Operation and Maintenance Data

**PART 2 - PRODUCTS**

Floor Drains  
Cleanouts  
Water Hammer Arrestors  
Backflow Preventers  
Wall Hydrants  
Hose Bibbs  
Manholes and Catch Basins  
Vent Flashings  
Washing Machine Wall Boxes

**PART 3 - EXECUTION**

Installation

**RELATED DOCUMENTS**

Section 22 11 00 - Facility Water Distribution  
Section 22 13 00 - Facility Sanitary Sewerage  
Section 22 05 23 - General-Duty Valves for Plumbing Piping

**REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

**QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC - General Conditions of the Contract, Equals and Substitutions..

Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

**SHOP DRAWINGS**

Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**FLOOR DRAINS**

Refer to plumbing specialties schedule on drawings.

**CLEANOUTS**

Refer to plumbing specialties schedule on drawings.

**WATER HAMMER ARRESTORS**

Manufacturer: PPP Industries, Sioux Chief, Wade, Watts.

1 ANSI A112.26.1, ASSE 1010; sized in accordance with PDI WH-201, precharged piston type constructed of hard  
2 drawn Type K copper, threaded brass adapter, brass piston with o-ring seals, FDA approved silicone lubricant,  
3 suitable for operation in temperature range 35 to 150 degrees F, maximum 250 psig working pressure, 1500 psig  
4 surge pressure. Watts series 15.

#### 6 **BACKFLOW PREVENTERS**

7 Refer to plumbing specialties schedule on drawings.

#### 9 **WALL HYDRANTS**

10 Refer to plumbing specialties schedule on drawings.

#### 12 **MANHOLES AND CATCH BASINS**

13 Precast reinforced concrete manhole sections, 48" diameter minimum manholes, 36" diameter minimum catch  
14 basins, ASTM C478. Construct base of 6" thick precast reinforced concrete or 8" thick cast in place concrete.  
15 Construct top of precast reinforced concrete eccentric cone and adjusting rings or 6" thick reinforced concrete slab  
16 with concentric opening.

17 Seal between sections with rubber ring gaskets, ASTM C443, or plastic preformed gasket material. Seal pipe  
18 penetrations with flexible watertight rubber gasketed seals.

19 Steps to be constructed of cast iron or polypropylene coated steel reinforcing rod.

20 Frame and cover or grate to be cast iron, ASTM A48, Class 35B, of style indicated, with minimum 24" diameter  
21 manhole opening, 20" diameter catch basin opening and pickhole. Provide gasketed self-sealing covers on sanitary  
22 manholes.

#### 27 **VENT FLASHINGS**

28 Manufacturers: Semco, Oatey.

29 Formed 3 lb./sq. ft. lead flashing with minimum base size of 15"x17".

#### 32 **WASHING MACHINE WALL BOXES**

33 Refer to plumbing specialties schedule on drawings.

### 36 **PART 3 - EXECUTION**

#### 38 **INSTALLATION**

39 Coordinate location and setting of plumbing specialties with adjacent construction. Install in accordance with  
40 manufacturers recommendations.

41 Set floor drains and cleanouts level and plumb adjusted to finished floor elevation or finished wall location. Locate  
42 where serviceable. Allow minimum of 18" clearance around cleanouts for rodding. Lubricate threaded cleanout  
43 plugs with graphite and oil, teflon tape or waterproof grease. Install trap primer connections where indicated.  
44 Install water hammer arrestors where indicated and at quick closing valve installations.

45 Install backflow preventers in accordance with Wis. Dept. of Safety and Professional Services requirements  
46 maintaining minimum clearance distances for servicing and testing. Provide indirect waste piping with air gap  
47 installation from relief opening to above hub drain or floor drain.

48 Install lab faucet vacuum breakers with Loctite 242 "blue" on threads.

49 Where backflow preventers requiring Dept. of Safety and Professional Services registration are installed, provide  
50 initial registration, testing and report filing required by Dept. of Safety and Professional Services. List the name and  
51 address of the building that the backflow preventer installations occur in.

52 Mount wall hydrants recessed in exterior wall construction with valve plug extended beyond interior side of building  
53 insulation. Slope to drain to exterior. Install so discharge is 18" min. above finished grade. Set wall box in grout or  
54 caulk and fill exterior wall penetration with insulation.

55 Mount hose bibbs securely fastened to wall where indicated. Provide water hammer arrestor in line to hose bibb.



1  
2 Excavate for manholes and catch basins setting precast bases on granular backfill and pouring cast in place bases on  
3 undisturbed soil. Seal joints between base, sections, collars and castings with gasketing material for tightly packed  
4 waterproof seals. Adjust casting to match finished grade. Form interior shelves with concrete grout for smooth  
5 flowlines conforming to the shape and slope of the sewer. Place piping into manholes providing full support of  
6 piping on exterior bedding and insuring pipe seals are properly installed and waterproof. Valve manholes and other  
7 manholes intended to remain dry must be made waterproof and are subject to infiltration testing. Backfill and  
8 compact soil around manhole or catch basin.  
9

10 Flash vent penetrations through roof. Turn down top of lead flashing into vent pipe. Tighten drawband of membrane  
11 boot to vent pipe. Adhere base flashing to deck or membrane. Provide waterproof patch around penetration on  
12 existing roofs.  
13

14 Install washing machine boxes in wall construction, secured to structure, directly behind proposed washing machine  
15 location. Provide water hammer arrestors in supply piping. Mount box a min. of 36" above floor.  
16  
17

18 END OF SECTION  
19



**SECTION 22 05 15**  
**PIPING SPECIALTIES**

**PART 1 - GENERAL**

**SCOPE**

This section contains specifications for plumbing piping specialties for all piping systems. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Reference

Shop Drawings

Operation and Maintenance Data

Design Criteria

**PART 2 - PRODUCTS**

Thermometers

Thermometer Sockets

**PART 3 - EXECUTION**

Thermometers

Thermometer Sockets

**RELATED WORK**

Section 22 11 00 - Facility Water Distribution

Section 22 13 00 - Facility Sanitary Sewerage

Section 22 05 23 - General-Duty Valves for Plumbing Piping

Section 22 07 00 - Plumbing Insulation

Section 22 30 00 - Plumbing Equipment

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC – General Conditions of the Contract, Equals and Substitutions.

**SHOP DRAWINGS**

Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, approvals, test data, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**DESIGN CRITERIA**

All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

**PART 2 - PRODUCTS**

**THERMOMETERS**

1 Ashcroft, Marsh, Taylor, H. O. Trerice, Ametek/U. S. Gauge, Weiss, Wika, Weksler.

2  
3 Stem Type: Cast aluminum case, nine inch scale, clear acrylic window. adjustable angle brass stem with stem of  
4 sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation,  
5 red indicating fluid, black lettering against a white background, with scale ranges as follows:  
6

7 <b>Service</b>	Hot Water
8 <b>Scale Range, °F</b>	30 - 180
9 <b>Increment, °F</b>	2

#### 10 11 **THERMOMETER SOCKETS**

12 Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in  
13 pipeline. Furnish with extension necks for insulated piping systems.  
14

### 15 16 **PART 3 - EXECUTION**

#### 17 18 **THERMOMETERS**

19 Stem Type: Install in piping systems as indicated on the drawings and/or details using a separable socket in each  
20 location.  
21

#### 22 **THERMOMETER SOCKETS**

23 Install at each point where a thermometer or temperature control sensing element is located in a pipeline.  
24  
25

26 **END OF SECTION**

**SECTION 22 05 23**  
**GENERAL DUTY VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**SCOPE**

This section includes valve specifications for all Plumbing systems except where indicated under Related Work. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Lead Free Requirements
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Design Criteria

**PART 2 - PRODUCTS**

- Water System Valves
  - Ball Valves
  - Spring Loaded Check Valves
  - Balance Valves
  - Drain Valves
  - Buried Water Service Valves
- Specialty Valves and Valve Accessories
- Gauge Valves

**PART 3 - EXECUTION**

- General
- Shut-off Valves
- Balancing Valves
- Drain Valves
- Spring Loaded Check Valves

**RELATED WORK**

Section 22 05 00 – Common Work Results for Plumbing  
Section 22 05 14 - Plumbing Specialties  
Section 22 30 00 - Plumbing Equipment

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**LEAD FREE REQUIREMENTS**

All materials that contact potable water shall be lead free. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content  $\leq 0.25\%$  per the Federal Safe Drinking Water Act as amended January 4th 2011 Section 1417.

**QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC - General Conditions of the Contract, Equals and Substitutions.

**SUBMITTALS**

Schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

## OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

## **DESIGN CRITERIA**

Valves to be line size unless specifically noted otherwise.

## **PART 2 - PRODUCTS**

### **WATER SYSTEM VALVES**

All water system valves to be rated at not less than 125 water working pressure at 240 degrees F unless noted otherwise.

#### **BALL VALVES:**

3" and smaller: Two piece bronze body; sweat or threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 600 psig WOG. Provide valve stem extensions for valves installed in all piping with insulation. Apollo 70LF-200, Hammond UP8511, Milwaukee UPBA150, Nibco S580-80-LF, Watts LFB-6081G2.

#### **SPRING LOADED CHECK VALVES:**

2" and smaller: Bronze body, sweat or threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, Class 125, teflon seat unless only bronze available. ConBraCo 61 series, Nibco S480-Y-LF, Watts LF600 or equal.

#### **BALANCE VALVES:**

2" and smaller: Two piece bronze body ball valve, sweat or threaded ends, chrome plated brass ball, glass filled teflon seat, threaded packing nut, with adjustable memory stop position indicator and extended handle stem, suitable for 400 psig water working pressure at 240 degrees F. Nibco S580-80-LF, Hammond UP8501-02 or UP8511-02, Milwaukee UPBA-100MS or UPBA-150MS or equal by Apollo, Watts,

#### **DRAIN VALVES:**

3/4 inch ball valve with integral threaded hose adapter, sweat or threaded inlet connections, with threaded cap and chain on hose threads, Apollo 70LF-200-HC, Milwaukee BA-100H or BA-150H Hammond 8501H or 8511H or equal by Nibco, or Watts.

#### **BURIED WATER SERVICE GATE VALVES:**

Cast iron body, resilient elastomer coated cast iron disc, permanently lubricated stuffing box, bronze non-rising stem and stem nut, double O-ring stem seal, Delrin thrust bearings, electroplated nuts and bolts, cast iron operating nut, AWWA C509, rated for 200 psi. Coat valve inside and out with fusion bonded epoxy, AWWA C550. Clow F-6100, Kennedy 1571, Mueller A-2360, Waterous 500, Watts 406RW.

Valve stem shall be stainless steel. Packing shall be permanent duty "chevron V-type" or "O-ring" type. Bearings shall be permanent, non-metallic, and self-lubricating.

Valve seat shall be a single piece of elastomeric material that is not penetrated by the valve shaft.

Provide manual operator that is suitable for underground service and includes a standard 2" square operating nut.

Valve shall be provided with mechanical joint connections.

Mueller, Clow, Henry Pratt, or approved equal.

### **VALVE BOXES**

GATE/BUTTERFLY VALVE BOXES:

1 Valve boxes shall be 5 1/4", cast iron valve boxes. Boxes shall be threaded, three-piece design with stay-put  
2 "WATER" cover. Provide appropriately sized bonnet.

3  
4 Provide valve box extensions as necessary to accommodate depth of cover shown on plans, or 6.5' minimum.

5  
6 Valve boxes shall be Tyler, or approved equal.  
7

### 8 9 **PART 3 - EXECUTION**

#### 10 11 **GENERAL**

12 Properly align piping before installation of valves. Install and test valves in strict accordance with valve  
13 manufacturer's installation recommendations. Do not support weight of piping system on valve ends.  
14

15 Mount valves in locations which allow access for operation, servicing and replacement.  
16

17 Provide valve handle extensions for all valves installed in insulated piping.  
18

19 Install all valves with the stem in the upright or horizontal position. If possible, install butterfly valves with the stem  
20 in the horizontal position. Valves installed with the stems down will not be accepted.  
21

22 Prior to flushing of piping systems, place all valves in the full-open position.  
23

#### 24 **SHUT-OFF VALVES**

25 Install shut-off valves at each piece of equipment, at each branch take-off from mains for isolation or repair and  
26 elsewhere as indicated.  
27

#### 28 **BALANCING VALVES**

29 Install where indicated on the drawings and details for balancing of flow in pumped hot water recirculation piping  
30 systems.

31 Upon project completion, adjust each valve and set position stop. Balance system to minimum flow in return piping  
32 branches needed to maintain even supply water temperature throughout building.  
33

#### 34 **DRAIN VALVES**

35 Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping  
36 systems, downstream of riser isolation valves, equipment locations specified or detailed, other locations required for  
37 drainage of systems and elsewhere as indicated.  
38

#### 39 **SPRING LOADED CHECK VALVES**

40 Install a spring loaded check valve in each circulating pump discharge line, each clearwater sump pump  
41  
42

43 **END OF SECTION**

1 **SECTION 22 05 29**  
2 **HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

3  
4 **PART 1 - GENERAL**

5  
6  
7 **SCOPE**

8 This section includes specifications for supports of all plumbing equipment and materials as well as piping system  
9 anchors. Included are the following topics:

10 **PART 1 - GENERAL**

11 Scope

12 Related Work

13 Reference

14 Quality Assurance

15 Description

16 Design Criteria

17 **PART 2 - PRODUCTS**

18 Manufacturers

19 Structural Supports

20 Pipe Hangers and Supports

21 **PART 3 - EXECUTION**

22 Installation

23 Hanger and Support Spacing  
24

25 **RELATED WORK**

26 Section 22 07 00 - Plumbing Insulation for insulation protection at support devices.  
27

28 **REFERENCE**

29 Applicable provisions of Division 1 shall govern work under this section.  
30

31 **REFERENCE**

32 Applicable provisions of Division 1 govern work under this section.  
33

34 **QUALITY ASSURANCE**

35 Substitution of Materials: Refer to Section GC - General Conditions of the Contract, Equals and Substitutions.  
36

37 **DESCRIPTION**

38 Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports  
39 and installation procedures are to conform to the latest requirements of the ANSI Code for building piping.  
40

41 Do not hang any mechanical so its rests on the bottom chord of any truss or joist.  
42

43 Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.  
44

45 Support apparatus and material under all conditions of operation, variations in installed and operating weight of  
46 equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.  
47

48 Protect insulation at all hanger points; see Related Work above.  
49

50 **DESIGN CRITERIA**

51 Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58  
52 unless noted otherwise.  
53



Piping connected to pumps is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

## PART 2 - PRODUCTS

### MANUFACTURERS

Anvil, B-Line, Pate, Piping Technology, Roof Products & Systems or approved equal.

### STRUCTURAL SUPPORTS

Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the drawings.

### PIPE HANGERS AND SUPPORTS

HANGERS FOR PIPE SIZES 1/2" THROUGH 2":

Carbon steel, adjustable swivel ring. B-Line B3170NF, Anvil 69 or 70.

Carbon steel, adjustable clevis, standard. B-Line B3100, Anvil 260.

### MULTIPLE OR TRAPEZE HANGERS:

Steel channels with welded spacers and hanger rods.

### WALL SUPPORT:

Carbon steel welded bracket with hanger. B-Line 3068 Series, Anvil 194 Series.

Perforated, epoxy painted finish, 16-12 gauge, min., steel channels securely anchored to wall structure, with interlocking, split-type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type PS 200 H with PS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil PS 1400 series.

### COPPER PIPE SUPPORTS:

All supports, fasteners, clamps, etc. directly connected to copper piping shall be copper plated or polyvinylchloride coated. Where steel channels are used, provide isolation collar between supports/clamps/fasteners and copper piping.

### PIPE HANGER RODS

#### STEEL HANGER RODS:

Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.

Size rods for individual hangers and trapeze support as indicated in the following schedule.

Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.)	Rod Diameter
<u>(650°F Maximum Temp.) (inches)</u>	
610	3/8
1130	1/2

## PART 3 - EXECUTION

## INSTALLATION

Size, apply and install supports and anchors in compliance with manufacturers recommendations.

Install supports to provide for free expansion of the piping system. Support all piping from the structure using ceiling plates, wall brackets, unistrut or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.

Coordinate hanger and support installation to properly group piping of all trades.

Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used and all data is submitted for prior approval.

Size and install hangers and supports for installation on the exterior of piping insulation. Where a vapor barrier is not required, hangers may be installed either on the exterior of pipe insulation or directly on piping.

Perform welding in accordance with standards of the American Welding Society.

## HANGER AND SUPPORT SPACING

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

Place a hanger within 12 inches of each horizontal elbow, valve, or similar piping specialty item.

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

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

Support riser piping independently of connected horizontal piping.

Adjust hangers to obtain the slope specified in the piping section of these specifications.

Space hangers for pipe as follows:

Pipe Material	Pipe Size	Max. Horiz. Spacing	Max. Vert. Spacing
Copper	1/2" through 3/4"	5'-0"	10'-0"
Copper	1" through 1-1/4"	6'-0"	10'-0"
Copper	1-1/2" through 2-1/2"	8'-0"	10'-0"
Steel	1/2" through 1-1/4"	7'-0"	15'-0"
Steel	1-1/2" through 6"	10'-0"	15'-0"
Plastic	Drain and Vent	4'-0"	10'-0"
Plastic	1" or less	32"	4'-0"
Plastic	1-1/4" and over	4'-0"	6'-0"

END OF SECTION



technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

#### OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

## **PART 2 - PRODUCTS**

### **MATERIALS**

Materials or accessories containing asbestos will not be accepted.

Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:

Insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 150.

### **INSULATION AND JACKETS**

Manufacturers: Armstrong, Certainteed Manson, Childers, Dow, Extol, Halstead, H.B. Fuller, Imcoa, Knauf, Owens-Corning, Pittsburgh Corning, Rubatex, Johns-Mansville, or approved equal.

Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.

#### **RIGID FIBERGLASS INSULATION:**

Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.

White kraft reinforced foil vapor barrier all service jacket, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

#### **FIREPROOFING INSULATION:**

Mineral fiber with nominal density of 8 lbs. per cu. ft., flame spread index of 15, fuel contribution index of 0, and smoke developed index of 0, thermal conductivity of not more than 0.23 at 75 degrees F.

Use fire proofing insulation where PVC piping is located in return air plenum areas. Refer to ceiling plenum drawing for extents of ceiling plenums utilized on this project.

#### **PVC FITTING COVERS AND JACKETS:**

White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Jacket thickness to be .02 inch (20 mil).

#### INSULATION INSERTS AND PIPE SHIELDS

Manufacturers: B-Line, Pipe Shields, Value Engineered Products

Construct inserts with calcium silicate, minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom of supported piping and full 360 degree coverage on clamped piping.

Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered pre-manufactured product described above.

Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x 6" block for piping through 2-1/2" and three 1" x 6"

1 blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/pre-  
2 manufactured product described above.

3  
4 Wood blocks will not be accepted.

### 5 6 **ACCESSORIES**

7 All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at  
8 operating temperatures of the systems to which they are applied.

9  
10 Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications  
11 specified.

12  
13 Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch  
14 for aluminum and .010 inch for stainless steel.

15  
16 Tack fasteners to be stainless steel ring grooved shank tacks.

17  
18 Staples to be clinch style.

19  
20 Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

21  
22 Finishing cement to be ASTM C449.

23  
24 Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.

25  
26 Bedding compounds to be non-shrinking and permanently flexible.

27  
28 Vapor barrier coatings to be non-flammable, fire resistant, polymeric resin.

29  
30 Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.

## 31 32 33 **PART 3 - EXECUTION**

### 34 35 **INSTALLATION**

36 Install insulation, jackets and accessories in accordance with manufacturer instructions and under ambient  
37 temperatures and conditions recommended by manufacturer. Surfaces to be insulated must be clean and dry.

38  
39 Do not insulate systems or equipment which are specified to be pressure tested or inspected, until testing, inspection  
40 and any necessary repairs have been successfully completed.

41  
42 Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted.  
43 Cover and seal exposed fiberglass insulation when insulation is terminated, no raw fiberglass insulation is allowed.  
44 Provide neat and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation  
45 terminates. Install with longitudinal joints facing wall or ceiling.

46  
47 Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.

48  
49 Use full-length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces  
50 cut undersize and stretched to fit will not be accepted.

51  
52 Insulation shall be continuous through sleeves and openings. Vapor barriers shall be maintained continuous through  
53 all penetrations.

54  
55 Provide a complete vapor barrier for insulation on the following systems:

- Cold water (potable and non-potable)

## PIPING, VALVE, AND FITTING INSULATION

### GENERAL:

Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive. Additionally secure with staples along seams and butt joints. Coat staples with vapor barrier mastic on systems requiring vapor barrier.

Water supply piping insulation shall be continuous throughout the building and installed adjacent to and within building walls to a point directly behind the fixture that is being supplied.

Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.

### INSULATION INSERTS AND PIPE SHIELDS:

Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

### FITTINGS AND VALVES:

Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Cover insulation with fabric reinforcing and mastic or where temperatures do not exceed 150 degrees, PVC fitting covers. Secure PVC fitting covers with tack fasteners and 1-1/2" band of mastic over ends, throat, seams or penetrations. On systems requiring vapor barrier, use vapor barrier mastic.

Lap seams and joints a minimum of 2 inches and continuously seal with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used.

### PIPE INSULATION SCHEDULE:

Provide insulation on new and existing remodeled piping as indicated in the following schedule:

Service	Insulation Types to 2"	Insulation Thickness by Pipe Size	
		1" and smaller	1-1/4"
Hot Water Supply	Rigid Fiberglass	1"	1"
Hot Water Circulating	Rigid Fiberglass	1"	1"
Cold Water	Rigid Fiberglass	0.5"	0.5"

The following piping and fittings are not to be insulated:

- Chrome plated exposed supplies and stops (except where specifically noted).
- Water hammer arrestors.
- Piping unions and flanges for systems not requiring a vapor barrier.

## EQUIPMENT INSULATION

Do not insulate over equipment access manholes, fittings, nameplates or ASME stamps. Bevel and seal insulation at these locations.







**SECTION 22 11 00**  
**FACILITY WATER DISTRIBUTION**

**PART 1 - GENERAL**

**SCOPE**

This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Reference
- Reference Standards
- Shop Drawings
- Quality Assurance
- Delivery, Storage, and Handling
- Design Criteria
- Welder Qualifications

**PART 2 - PRODUCTS**

- Domestic Water
- Unions and Flanges

**PART 3 - EXECUTION**

- General
- Preparation
- Erection
- Copper Pipe Joints
- Threaded Pipe Joints
- Solvent Welded Pipe Joints
- Mechanically Formed Tee Fittings
- Domestic Water
- Underground Pipe Wrap
- Unions and Flanges
- Piping System Leak Tests

**RELATED WORK**

22 05 29 - Hangers and Supports for Plumbing Piping and Equipment  
22 05 14 - Plumbing Specialties

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**SHOP DRAWINGS**

Schedule from the contractor indicating the ASTM, AWWA or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.

**QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC – General Conditions of the Contract, Equals and Substitutions.

**DELIVERY, STORAGE, AND HANDLING**

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

Offsite storage agreements will not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

## **DESIGN CRITERIA**

Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, AWWA or CISPI specifications as listed in this specification.

Construct all piping for the highest pressures and temperatures in the respective system.

Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.

Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

## **PART 2 - PRODUCTS**

### **DOMESTIC WATER**

#### **ABOVE GROUND:**

Type L copper water tube, H (drawn) temper, ASTM B88; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP. Copper mechanical grooved fittings and couplings on roll grooved pipe may be used in lieu of soldered fittings. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for branch takeoffs up to one-half (1/2) the diameter of the main.

#### **BELOW GROUND 2-1/2" AND SMALLER:**

Type K copper water tube, O (annealed) temper, ASTM B88; with cast copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; or cast copper flared pressure fittings, ANSI B16.26.

### **UNIONS AND FLANGES**

Unions, flanges and gasket materials to have a pressure rating of not less than 150 psig at 180 degrees. Gasket material for flanges and flanged fittings shall be teflon type. Treated paper gaskets are not acceptable.

#### **2" AND SMALLER STEEL:**

ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping.

#### **2" AND SMALLER COPPER:**

ANSI B16.18 cast bronze union coupling or ANSI B15.24 Class 150 cast bronze flanges.

## **PART 3 - EXECUTION**

### **GENERAL**

1 Install pipe and fittings in accordance with reference standards, manufacturers recommendations and recognized  
2 industry practices.

### 4 **PREPARATION**

5 Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each  
6 section of pipe and fitting prior to assembly.

### 8 **ERECTION**

9 Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a  
10 window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as  
11 required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and  
12 equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe  
13 spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

14  
15 Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric  
16 pipe insulation.

17  
18 Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where  
19 existing underground warning tape is encountered, repair and replace.

20  
21 Maintain piping in clean condition internally during construction.

22  
23 Provide clearance for installation of insulation, access to valves and piping specialties.

24  
25 Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the  
26 required service space for this equipment, unless the piping is serving this equipment

27  
28 Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide  
29 access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed  
30 by others where same requires the piping services indicated in this section.

### 31 32 **COPPER PIPE JOINTS**

33 Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean  
34 fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux  
35 and assemble joint to socket stop. Apply flame to fitting until solder melts when placed at joint. Remove flame and  
36 feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

### 37 38 **THREADED PIPE JOINTS**

39 Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be  
40 allowed.

### 41 42 **SOLVENT WELDED PIPE JOINTS**

43 Install in accordance with ASTM D2855 "Making Solvent Cemented Joints With PVC Pipe and Fittings". Saw cut  
44 piping square and smooth. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC  
45 pipe that do not leave a raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and  
46 scratches. Bevel ends 10-15 degrees and deburr interior. Remove dust, drips, moisture, grease and other superfluous  
47 materials from pipe interior and exterior. Check dry fit of pipe and fittings. Reject materials which are out of round  
48 or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.

49  
50 Maintain pipe, fittings, primer and cement between 40 and 100 degrees during application and curing. Apply primer  
51 and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about 1/2 the size of  
52 the pipe diameter. Apply primer to the fitting socket and pipe surface with a scrubbing motion. Check for  
53 penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths. Apply solvent cement to the  
54 fitting socket and pipe in an amount greater than needed to fill any gap. While both surfaces are wet, insert pipe into

socket fitting with a quarter turn to the bottom of the socket. Solvent cement application and insertion must be completed in less than 1 minute.

#### **MECHANICALLY FORMED TEE FITTINGS**

Form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint with neutral flame oxy-acetylene torch, applying heat properly so that pipe and tee do not distort; remove distorted connections.

#### **DOMESTIC WATER**

Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.

Install exterior water piping below predicted frost level in accordance with COMM Table 82.30-6, but in no case less than 6' bury depth to top of pipe. Maintain minimum of 30" horizontal and 12" vertical distance, water on top, between 2" and smaller water piping and sanitary sewer piping. Where water piping crosses a sanitary sewer, provide minimum 18" vertical clearance and waterproof PVC water pipe sleeve (reference sanitary sewer materials) sealed at both ends for distance of 10' from sewer in both directions.

Field apply continuous anti-corrosion coating to rodded restraint components. Protect mechanical joints, nuts and bolts from concrete cover. Cover with 8 mil sheet or tube polyethylene material sleeve.

Install interior water piping with drain valves where indicated and at low points of system to allow complete drainage. Do not install water piping within exterior walls.

Prior to use, isolate and fill system with potable water. Allow to stand 24 hours. Flush each outlet proceeding from the service entrance to the furthest outlet for minimum of 1 minute and until water appears clear. Fill system with a solution of water and chlorine containing at least 50 parts per million of chlorine and allow to stand for 24 hours. Alternately a solution containing at least 200 parts per million of chlorine may be used and allowed to stand for 3 hours. Flush system with potable water until chlorine concentration is no higher than source water level.

Wait 24 hours after final flushing. Take samples of water for lab testing. The number and location of samples shall be representative of the system size and configuration and are subject to approval by Engineer. Test shall show the absence of coliform bacteria. If test fails, repeat disinfection and testing procedures until no coliform bacteria are detected. Submit test report indicating date and time of test along with test results.

#### **UNDERGROUND PIPE WRAP**

Use for steel piping encased in concrete or underground which is not in a conduit. Remove all dirt and other foreign material from exterior of pipe. Apply primer as recommended by the manufacturer. Use a spiral wrap process for applying tape to the pipe. Repair any breaks in the tape coating caused by the installation process.

#### **DIELECTRIC UNIONS AND FLANGES**

Install dielectric unions or flanges at each point where a copper-to-steel pipe connection is required in domestic water systems.

#### **UNIONS AND FLANGES**

Install a union or flange at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

#### **PIPING SYSTEM LEAK TESTS**

Isolate or remove components from system which are not rated for test pressure. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.

Hydrostatic testing of fire suppression to be witnessed by Plumbing Contractor. Plumbing Contractor to coordinate with Fire Protection contractor and make any necessary repairs to piping system between BFP-1 and connection to "limited area sprinkler system" where shown on the drawings.

If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.

For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.

Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.

All pressure tests are to be documented and be provided to the General Contractor.

System	Test Medium	Initial Test		Final Test	
		Pressure	Duration	Pressure	Duration
*Below Ground Domestic	Water	Water	N/A	200 psig	2 hr
Above Ground Domestic	Water	Water	N/A	100 psig	8 hr

\* Leakage on exterior mains 3" and larger may not exceed leakage calculated as follows:

$$\text{GPH Allowable Leakage} = \frac{(\text{Feet of Pipe}) (\text{Inches Dia. of Pipe}) (\text{Test Pressure})^{.5}}{133,200}$$

END OF SECTION



**SECTION 22 13 00  
FACILITY SANITARY SEWERAGE**

**PART 1 - GENERAL**

**SCOPE**

This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Reference
- Shop Drawings
- Quality Assurance
- Delivery, Storage, and Handling
- Design Criteria
- Welder Qualifications

**PART 2 - PRODUCTS**

- Sanitary Waste and Vent

**PART 3 - EXECUTION**

- General
- Preparation
- Erection
- Copper Pipe Joints
- Threaded Pipe Joints
- Solvent Welded Pipe Joints
- Mechanically Formed Tee Fittings
- Sanitary Waste and Vent
- Piping System Leak Tests

**RELATED WORK**

22 05 29 - Hangers and Supports for Plumbing Piping and Equipment  
22 05 14 - Plumbing Specialties

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**SHOP DRAWINGS**

Schedule from the contractor indicating the ASTM, or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.

**QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC – General Conditions of the Contract, Equals and Substitutions.

Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.

**DELIVERY, STORAGE, AND HANDLING**

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

1 Offsite storage agreements will not relieve the contractor from using proper storage techniques.

2  
3 Storage and protection methods must allow inspection to verify products.

#### 4 **DESIGN CRITERIA**

5 Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, or CISPI  
6 specifications as listed in this specification.

7  
8  
9 Construct all piping for the highest pressures and temperatures in the respective system.

10  
11 Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation  
12 plenum spaces, including plenum ceilings.

13  
14 Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at  
15 Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially  
16 available.

17  
18 Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper  
19 copper tubing may be substituted at Contractor's option.

## 20 21 **PART 2-PRODUCTS**

### 22 23 **SANITARY WASTE AND VENT**

#### 24 **INTERIOR ABOVE GROUND:**

25 Hubless cast iron soil pipe and fittings, ASTM A888; with no-hub couplings, CISPI 301, CISPI 310, ASTM A74.  
26 Pipe and fittings shall be marked with the collective trademark of the Cast Iron Pipe Institute or receive prior  
27 approval of the Engineer. Cast iron piping and fittings shall be of A B & I Foundry, Charlotte Pipe and Foundry, or  
28 Tyler Pipe manufacturers.

29  
30 Type M copper water tube, H (drawn) temper, ASTM B88; with cast copper drainage fittings (DWV), ANSI  
31 B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder, ASTM B32; flux, ASTM  
32 B813; copper phosphorous brazing alloy, AWS A5.8 BCuP.

33 PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe  
34 and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM  
35 D2564.

36  
37  
38 Galvanized steel pipe, Schedule 40, Type F, Grade A, ASTM A53; with cast iron threaded drainage fittings, ASTM  
39 B16.12.

#### 40 41 **INTERIOR BELOW GROUND:**

42 Cast iron soil pipe and fittings, hub and spigot, service weight, ASTM A74, with neoprene rubber compression  
43 gaskets, ASTM C564, CISPI 301, and CISPI HSN 85. Pipe and fittings shall be marked with the collective  
44 trademark of the Cast Iron Pipe Institute. Cast iron piping and fittings shall be of A B & I Foundry, Charlotte Pipe  
45 and Foundry, or Tyler Pipe manufacturers.

46  
47 PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe  
48 and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM  
49 D2564.

#### 50 51 **EXTERIOR BELOW GROUND:**

52 Non-reinforced concrete sewer, storm drain and culvert pipe, Class III, ASTM C14; rubber gasket joints, ASTM  
53 C443; bell and spigot ends with opposing shoulder or confined O-ring seal configuration, ASTM C302.



PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

Type PSM PVC sewer pipe and socket fittings, SDR 35, Class 12454-B (PVC 1120), ASTM D3034; primer, ASTM F656; solvent cement, ASTM 2564; or integral bell and flexible elastomeric seal, ASTM D3212.

## **PART 3 - EXECUTION**

### **GENERAL**

Install pipe and fittings in accordance with reference standards, manufacturers recommendations and recognized industry practices.

### **PREPARATION**

Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

### **ERECTION**

Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.

Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.

Maintain piping in clean condition internally during construction.

Provide clearance for installation of insulation, access to valves and piping specialties.

Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment

Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

### **COPPER PIPE JOINTS**

Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux and assemble joint to socket stop. Apply flame to fitting until solder melts when placed at joint. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

### **THREADED PIPE JOINTS**

Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

### **SOLVENT WELDED PIPE JOINTS**

Install in accordance with ASTM D2855 "Making Solvent Cemented Joints With PVC Pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and

scratches. Bevel ends 10-15 degrees and deburr interior. Remove dust, drips, moisture, grease and other superfluous materials from pipe interior and exterior. Check dry fit of pipe and fittings. Reject materials which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.

Maintain pipe, fittings, primer and cement between 40 and 100 degrees during application and curing. Apply primer and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about 1/2 the size of the pipe diameter. Apply primer to the fitting socket and pipe surface with a scrubbing motion. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths. Apply solvent cement to the fitting socket and pipe in an amount greater than needed to fill any gap. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to the bottom of the socket. Solvent cement application and insertion must be completed in less than 1 minute.

### **SANITARY WASTE AND VENT**

Verify invert elevations and building elevations prior to installation. Install exterior piping pitched to drain at indicated elevations and slope. Install interior piping pitched to drain at minimum slope of 1/4" per foot where possible and in no case less than 1/8" per foot for piping 3" and larger.

Install exterior piping below predicted frost level and not less than 5' bury depth to top of pipe wherever possible. Where piping is located above predicted frost level, provide frost protection in accordance with SPS 382.30(11)(c).

Flush piping inlets (floor drains, hub drains, mop basins, fixtures, etc.) with high flow of water at completion of project to demonstrate full flow capacity. Remove blockages and make necessary repairs where flow is found to be impeded.

### **PIPING SYSTEM LEAK TESTS**

Isolate or remove components from system which are not rated for test pressure. Perform final testing for medical and lab gas with all system components in place. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.

If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.

For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.

For air or nitrogen tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.

Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.

All pressure tests are to be documented and be provided to the General Contractor.

System	Test Medium	<u>Initial Test</u>		<u>Final Test</u>	
		Pressure	Duration	Pressure	Duration
Sanitary Waste and Vent	Water	N/A		10' water	2 hr

END OF SECTION

**SECTION 22 30 00**  
**PLUMBING EQUIPMENT**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for water heaters, water softeners, pumps and other equipment used for plumbing applications. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Documents
- Reference
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data

**PART 2 - PRODUCTS**

- Water Heaters
- Pumps
- Controls

**PART 3 - EXECUTION**

- Installation

**RELATED DOCUMENTS**

Section 22 05 23 - General-Duty Valves for Plumbing Piping  
Section 22 05 15 - Piping Specialties  
Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.  
Section 22 07 00 - Plumbing Insulation  
Division 26 00 00 - Electrical

**REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

**QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC - General Conditions of the Contract, Article 7.

Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

**SHOP DRAWINGS**

Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, pump curves with net positive suction head requirements, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**HIGH EFFICIENCY COMMERCIAL GAS FIRED WATER HEATER**

Manufacturers: A.O. Smith, Bradford White, Bock, Lochinvar, State.

Type: Gas fired sealed combustion condensing commercial storage water heater, minimum 92% thermal efficiency. Design to be AGA certified with 3 year tank warranty and 1 year parts warranty.

1 Tank: Steel glass lined tank rated for 150 psig complete with multiple removable magnesium anode rods or single  
2 impressed current anode rod, submerged combustion chamber, 4" tank access hand hole, foam insulation, painted  
3 steel jacket, brass drain valve and temperature and pressure relief valve.

4  
5 Burner: Top mounted down fired premix low NOx power burner.

6  
7 Controls: 120 volt, 1 phase, 60 Hz electronic controls, intermittent spark or hot surface ignition, operating  
8 thermostat with 110°-180°F adjustable temperature control, energy cutoff with manual reset, blower pressure switch,  
9 gas valve and pressure regulator.

10  
11 Vent: PVC, CPVC or ABS combustion air intake and flue gas outlet with DWV solvent weld fittings. Refer to  
12 equipment recommendation for vent material.

### 13 14 15 **IN-LINE CENTRIFUGAL PUMPS**

16 Manufacturer: Bell and Gossett, Gould, Grundfos, Taco.

17  
18 Type: Horizontal single stage oil lubricated in-line pumps, 125 psig maximum working pressure at operating  
19 temperature of 225°F. continuous. The manufacturer shall certify all pump ratings. All pumps to operate without  
20 excessive noise or vibration.

21  
22 Casing: Bronze or stainless steel; flanged suction and discharge connection.

23  
24 Impeller: Brass or bronze, keyed to the shaft, single suction enclosed type, hydraulically and dynamically balanced.

25  
26 Bearings: Oil lubricated bronze sleeve or ball bearings.

27  
28 Shaft: Stainless steel or carbon steel with stainless steel or bronze sleeve, integral thrust collar.

29  
30 Seal: Mechanical type, carbon rotating against a stationary ceramic seat, 225°F maximum continuous operating  
31 temperature.

32  
33 Drive: Flexible coupling.

34  
35 Motor: Provide pump with open drip proof motor with built-in thermal overload protection sized for non-  
36 overloading over the entire pump curve. Furnish each pump and motor with a nameplate giving the manufacturer's  
37 name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage,  
38 frequency, speed and full load current.

### 39 40 41 **EXPANSION TANKS**

42 Manufacturer: Amtrol, Bell and Gossett, Wessels.

43  
44 Vertical steel precharged hydro-pneumatic expansion tank, 125 psi ASME labeled construction, complete with  
45 replaceable flexible butyl rubber bladder, system connection fitting, Schrader type air charge fitting, steel base ring  
46 stand, factory prime and enamel painted exterior finish, ASME relief valve. Materials exposed to water to be NSF or  
47 FDA approved for potable water service.

## 48 49 50 **PART 3 - EXECUTION**

### 51 52 **INSTALLATION**

53 Install plumbing equipment where indicated in accordance with manufacturer's recommendations. Coordinate  
54 equipment location with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances.  
55 Locate equipment and arrange plumbing piping to provide access space for servicing all components.

1  
2 Set commercial water heater on concrete housekeeping pad. Adjust and level equipment.  
3  
4 Connect equipment to water and drain piping using unions or flanges and isolation valves.  
5  
6 Size temperature and relief valves per CSA ratings. Pipe temperature and pressure relief valves to floor drain or  
7 floor as indicated.  
8  
9 Startup and test equipment adjusting operating and safety controls for proper operation.  
10  
11 Lubricate pumps before startup. Adjust pumps for rated flow. Clean and blowdown strainers after 8 hours of  
12 operation.  
13  
14 Adjust compression tank precharge to scheduled minimum operating pressure prior to connecting to system.  
15  
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END OF SECTION



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**SECTION 22 42 00**  
**COMMERCIAL PLUMBING FIXTURES**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for plumbing fixtures, faucets and trim.

**PART 1 - GENERAL**

Scope

Related Work

Quality Assurance

Shop Drawings

Operation and Maintenance Data

Design Criteria

Energy Efficiency Requirements

**PART 2 - PRODUCTS**

Plumbing Fixtures

**PART 3 - EXECUTION**

Installation

Construction Verification Items

**RELATED WORK**

Section 22 11 00 - Facility Water Distribution

Section 22 13 00 - Facility Sanitary Sewerage

Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

Section 22 05 14 - Plumbing Specialties

**REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

**QUALITY ASSURANCE**

Substitution of Materials: Refer to Section GC - General Conditions of the Contract, Equals and Substitutions.

Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

**SHOP DRAWINGS**

Include data concerning sizes, utility sizes, rough in-dimensions, capacities, materials of construction, ratings, weights, trim, finishes, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**ENERGY EFFICIENCY REQUIREMENTS**

Plumbing fixtures must meet the following maximum water usage requirements which are based upon Federal Energy Management Program (FEMP) performance requirements.

- a. Lavatory Faucets, flow of 2 gpm or less and .25 gallon per cycle or less (based on inlet pressure of 60 p.s.i.)
- b. Showerheads, flow of 2.2 gpm or less (based on inlet pressure of 80 p.s.i.)
- c. Urinal Flush Valves, 1.0 gallon per flush or less.
- d. Water Closet Flush Valves, 1.6 gallon per flush or less.

## **PART 2-PRODUCTS**

### **PLUMBING FIXTURES**

Manufacturers: Fixture descriptions in fixture schedule (refer to drawings) establish fixture type, quality, materials, features and size. Products of the manufacturers listed in the plumbing fixture schedule will be accepted.

## **PART 3-EXECUTION**

### **INSTALLATION**

Install plumbing fixtures in accordance with manufacturer instructions. Set level and plumb. Secure in place to counters, floors and walls providing solid bearing and secure mounting. Bolt fixture carriers to floor and wall. Secure rough-in fixture piping to prevent movement of exposed piping.

Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.

Install barrier free fixtures in compliance with IBC 1108 and 3408, COMM 52, 69 and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above floor to avoid contact by wheelchair users.

Provide unions at water connections to drinking fountains and electric water coolers.

Each fixture shall have a stop valve installation to control the fixture. Stop valves shall be heavy duty type with brass stems and screwed or sweat inlet connections. Compression type inlets are not acceptable.

Cover pipe penetrations with escutcheons. Exposed traps, stops, piping and escutcheons to be chrome plated brass, same items in concealed locations may be of rough brass finish.

Set floor mounted water closets, floor mounted service sinks; counter mounted lavs and sinks; lav and sink faucets and drains with full setting bed of flexible non-staining plumber's putty. Cover exposed water closet bolts with bolt covers.

Set mop basins to floor and wall with grout or silicone sealant.

Seal openings between walls, floors and fixtures with mildew-resistant silicone sealant same color as fixture.

Test fixtures to demonstrate proper operation. Replace malfunctioning units or components. Adjust valves for intended water flow rate to fixtures without splashing, noise or overflow. Adjust self-closing lavatory faucets to 15 second cycle. Adjust shower valve temperature limit stops to 110 degree maximum outlet temperature.

Protect fixtures during construction. At completion clean plumbing fixtures and trim using manufacturer's recommended cleaning methods and materials.

END OF SECTION



**SECTION 23 05 00  
COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

**SCOPE**

This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Quality Assurance
- Protection of Finished Surfaces
- Sleeves and Openings
- Sealing and Fire Stopping
- Submittals
- Certificates and Inspections
- Operating and Maintenance Data
- Training of Owner Personnel
- Record Drawings

**PART 2 - PRODUCTS**

- Access Panels and Doors
- Identification
- Sealing and Fire Stopping

**PART 3 - EXECUTION**

- Demolition
- Concrete Work
- Cutting and Patching
- Building Access
- Equipment Access
- Coordination
- Identification
- Lubrication
- Sleeves and Openings
- Sealing and Fire Stopping
- Owner Training

**RELATED WORK**

Section 07 84 00 - Fire Stopping  
Section 23 33 00 - Air Duct Accessories.

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**QUALITY ASSURANCE**

Refer to Division 1, General Conditions, Equals and Substitutions.

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

**PROTECTION OF FINISHED SURFACES**

Refer to Division 1, General Requirements, Protection of Finished Surfaces.

Furnish one can of touch-up paint for each different color factory finish which is to be the final finished surface of the product. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

**SLEEVES AND OPENINGS**

Refer to Division 1, General Requirements, Sleeves and Openings.

## **SEALING AND FIRE STOPPING**

Sealing and fire stopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 Fire Stopping.

## **SUBMITTALS**

Refer to Division 1, General Conditions, Submittals.

Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.

Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Include a statement on the shop drawing transmittal to the architect/engineer that the equipment submitted and the motor starter schedules are in agreement or indicate any discrepancies. See related comments in Section 23 05 13 in Part 1 under Electrical Coordination.

Include wiring diagrams of electrically powered equipment.

Submit sufficient quantities of shop drawings to allow the following distribution:

- |   |          |
|---|----------|
| • Operating and Maintenance Manuals           | 2 copies |
| • Testing, Adjusting and Balancing Contractor | 1 copy   |
| • A/E   | 1 copy   |

## **CERTIFICATES AND INSPECTIONS**

Refer also to Division 1, General Conditions, Permits, Regulations, Utilities and Taxes.

Obtain and pay for all required State installation inspections except those provided by the Architect/Engineer in accordance with code. Deliver originals of these certificates to the General Contractor. Include copies of the certificates in the Operating and Maintenance Instructions.

## **OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. Records of tests performed to certify compliance with system requirements
2. Certificates of inspection by regulatory agencies
3. Valve schedules
4. Lubrication instructions, including list/frequency of lubrication
5. Copies of all approved shop drawings.
6. Manufacturer's wiring diagrams for electrically powered equipment
7. Control sequences
8. Parts lists for manufactured equipment
9. Warranties
10. Additional information as indicated in the technical specification sections

## **TRAINING OF OWNER PERSONNEL**

Instruct user agency personnel in the proper operation and maintenance of systems and equipment provided as part of this project; video tape all training sessions. Include not less than 8 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

## **RECORD DRAWINGS**

Refer to Division 1, General Requirements, Record Drawings.

In addition to the data indicated in the General Requirements, maintain temperature control record drawings on originals prepared by the installing contractor/subcontractor. Include copies of these record drawings with the Operating and Maintenance manuals.

## PART 2 - PRODUCTS

### ACCESS PANELS AND DOORS

#### LAY-IN CEILINGS:

Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Section 09500 are sufficient; no additional access provisions are required unless specifically indicated.

### IDENTIFICATION

#### STENCILS:

Not less than 1 inch high letters/numbers for marking pipe and equipment.

#### SNAP-ON PIPE MARKERS:

Cylindrical self-coiling plastic sheet that snaps over piping insulation and is held tightly in place without the use of adhesive, tape or straps. Not less than 1 inch high letters/numbers and flow direction arrows for piping marking. W. H. Brady, Seton, Marking Services, or equal.

#### ENGRAVED NAME PLATES:

White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, or W. H. Brady.

#### VALVE TAGS:

Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains or brass "S" hooks around the valve stem, available from EMED Co., Seton Name Plate Company, Marking Services, or W. H. Brady.

### SEALING AND FIRE STOPPING

#### FIRE AND/OR SMOKE RATED PENETRATIONS:

Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 "Fire Stopping".

#### NON-RATED PENETRATIONS:

##### Pipe Penetrations:

At pipe penetrations of non-rated interior walls, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood walls where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

##### Duct Penetrations:

Annular space between duct (with or without insulation) and the non-rated walls or floor opening shall not be larger than 2". Where existing openings have an annular space larger than 2", the space shall be patched to match existing construction to within 2" around the duct.

In finished spaces where duct penetrations will be exposed, patch annular space to match existing construction.

## PART 3 - EXECUTION

### CONCRETE WORK

Mechanical Contractor shall provide concrete housekeeping pad for all floor mounted equipment. Coordinate with Plumbing Contractor prior to construction with respect to floor cleanouts, hub drains, floor drains, etc.

### CUTTING AND PATCHING

Refer to Division 1, General Requirements, Cutting and Patching.

### BUILDING ACCESS

Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

### EQUIPMENT ACCESS

1 Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service.  
2 Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure  
3 that access is available for all equipment and specialties. Access doors in general construction are to be furnished by  
4 the Mechanical Contractor and installed by the General Contractor.

5  
6 Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not  
7 require access panels.

## 8 9 **COORDINATION**

10 Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited  
11 to, diffusers, register, grilles, and recessed or semi-recessed heating and/or cooling terminal units installed in/on  
12 architectural surfaces.

13  
14 Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that  
15 interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

16  
17 Cooperate with the test and balance agency in ensuring Section 23 05 93 specification compliance. Verify system  
18 completion to the test and balance agency (pressure testing, clean filters, duct and pipe systems cleaned, controls  
19 adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing  
20 work. Install dampers, shutoff and balancing valves, temperature controls, etc., required for functional and balanced  
21 systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency  
22 can perform its work.

## 23 24 **IDENTIFICATION**

25 Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of  
26 black enamel against a light background or white enamel against a dark background. Use a primer where necessary  
27 for proper paint adhesion. Do not label equipment such as heaters and ceiling fans in occupied spaces.

28  
29 Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

30  
31 Identify piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or  
32 panel, and on both side of the partition where exposed piping passes through walls, floors or roofs. Place flow  
33 directional arrows at each pipe identification location. Use one coat of black enamel against a light background or  
34 white enamel against a dark background for stenciling, or provide snap-on pipe markers as specified in Part 2 –  
35 Products.

36  
37 Identify valves with brass tags bearing a system identification and a valve sequence number. Provide a typewritten  
38 valve schedule indicating the valve number and the equipment or areas supplied by each valve; locate schedules in  
39 each mechanical room and in each Operating and Maintenance manual. Schedules in mechanical rooms to be  
40 framed under clear plastic.

41  
42 Use engraved name plates to identify control equipment.

43  
44 Label fire dampers on the exterior surface of ductwork directly adjacent to access doors using a minimum of 0.5  
45 inch height lettering reading "FIRE DAMPER". Utilize stencils or manufactured labels. All other forms of  
46 identification are unacceptable. All labels shall be clearly visible from the ceiling access point.

## 47 48 **LUBRICATION**

49 Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any  
50 reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions  
51 until the work is accepted by Owner. Maintain a log of all lubricants used and frequency of lubrication; include this  
52 information in the Operating and Maintenance Manuals at the completion of the project.

## 53 54 **DUCT SLEEVES:**

55 Duct sleeves are not required in non-rated partitions or floors.

56  
57 Provide sleeve required for fire dampers in fire-rated partitions and floors. Reference fire damper details on  
58 drawings.

## 59 60 **SEALING AND FIRE STOPPING**

### 61 **FIRE AND/OR SMOKE RATED PENETRATIONS**

62 Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with  
63 section 07 84 00 Fire Stopping.

1  
2 NON-RATED PENETRATIONS:

3 At all interior walls and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the  
4 penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or  
5 insulation is completely blocked.  
6

7 Duct penetrations through non-rated partitions shall require sheet metal escutcheons with fiberglass or mineral wool  
8 insulation fill for spaces that include janitor closets, toilet rooms, mechanical rooms, training room, private  
9 consultation rooms, where ducts are exposed and where noted on drawings elsewhere.  
10

11  
12 END OF SECTION



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**SECTION 23 05 23**  
**GENERAL-DUTY VALVES FOR HVAC PIPING**

**PART 1 - GENERAL**

**SCOPE**

This section includes valve specifications for all HVAC systems except where indicated under Related Work. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Design Criteria

**PART 2 - PRODUCTS**

- Manufacturers
- Natural Gas Systems
  - Shut-off Valves
  - Gas Pressure Regulators

**PART 3 - EXECUTION**

- Shut-off Valves
- Gas Pressure Regulators

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**QUALITY ASSURANCE**

Refer to division 1, General Conditions, Equals and Substitutions.

**SUBMITTALS**

Refer to division 1, General Conditions, Submittals.

Contractors shall submit a schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**PART 2 - PRODUCTS**

**NATURAL GAS SYSTEMS**

**SHUT OFF VALVES:**

2" and smaller: Ball valve, bronze body, threaded ends, chrome-plated bronze or stainless steel ball, full or conventional port, teflon seat, blowout-proof stem, two-piece construction, suitable for 150 psig working pressure, U.L. listed for use as natural gas shut-off.

DeZurik, Homestead, Rockwell, Walworth.

**GAS PRESSURE REGULATORS:**

2" and smaller: Cast iron body, aluminum spring and diaphragm, Nitrile diaphragm, threaded ends, 150 psi W.O.G., -20°F to 150°F.

**PART 3 - EXECUTION**

**GENERAL**

1 Properly align piping before installation of valves in an upright position; operators installed below the valves will  
2 not be accepted.

3  
4 Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of  
5 piping system on valve ends.

6  
7 Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal  
8 position only where space limitations do not allow installation in an upright position or where large valves are  
9 provided with chain wheel operators. Valves installed with the stems down, will not be accepted.

## 10 11 12 **GAS PRESSURE REGULATORS**

13 When the gas pressure regulator is equipped with a vent connection, run a connection size vent to outside air in  
14 accordance with codes. Use a larger size vent when required by the manufacturer's installation instructions.

15  
16  
17 **END OF SECTION**



**SECTION 23 05 29**  
**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for supports of all HVAC equipment and materials as well as piping system anchors. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Quality Assurance
- Description
- Shop Drawings
- Design Criteria

**PART 2 - PRODUCTS**

- Pipe Hanger and Support Manufacturers
- Structural Supports
- Pipe Hangers and Supports
- Wood Structure Supports

**PART 3 - EXECUTION**

- Installation
- Hanger and Support Spacing

**RELATED WORK**

Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment  
Section 23 07 00 - HVAC Insulation

**REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

**QUALITY ASSURANCE**

Refer to Division 1, General Conditions, Equals and Substitutions.

**DESCRIPTION**

Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.

Gas-fired unit heater to be supported from top truss cord, hanger rod to extend past drywall lid. Coordinate installation with general contractor.

Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

Protect insulation at all hanger points; see Related Work above.

**SHOP DRAWINGS**

Refer to division 1, General Conditions, Submittals.

Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference section 23 05 00.

**DESIGN CRITERIA**

Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 unless noted otherwise.

Piping connected to rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

Piping flexible connections and vibration isolation supports are required for piping connected to coils that are in a fan assembly where the entire assembly is mounted on vibration supports; the vibration isolation supports are

required for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Piping flexible connection and vibration isolation supports are not required when the fan section is separately and independently isolated by means of vibration supports and duct flexible connections. Standard pipe hangers/supports as specified in this section are required when there are no vibration isolation devices in the piping and beyond the 100 pipe diameter/3 support distance.

Piping supported by laying on the bottom chord of joists or trusses will not be accepted.

Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.

Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.

## PART 2 - PRODUCTS

### PIPE HANGER AND SUPPORT MANUFACTURERS

Anvil, B-Line, Fee and Mason, Kindorf, Michigan Hanger, Unistrut, or approved equal. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

### STRUCTURAL SUPPORTS

Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support equipment.

### PIPE HANGERS AND SUPPORTS

HANGERS FOR STEEL PIPE SIZES 1/2" THROUGH 2":

Carbon steel, adjustable, clevis, black finish. Anvil figure 65 or 260.

### MULTIPLE OR TRAPEZE HANGERS:

Steel channels with welded spacers and hanger rods if calculations are submitted.

### WALL SUPPORT:

Welded steel bracket with hanger. B-Line 3068 Series, Anvil 194 Series.

Perforated epoxy painted finish, 16-12 gauge min., steel channels securely anchored to wall structure with interlocking, split type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type AS200 H with AS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil cushion clamp assembly.

### COPPER PIPE SUPPORT:

Carbon steel ring, adjustable, copper plated or polyvinylchloride coated.

### INSULATION PROTECTION SHIELDS:

Galvanized carbon steel of not less than 18 gauge for use on insulated pipe 2-1/2 inch and larger. Minimum shield length is 12 inches. Equal to Anvil figure 167.

### STEEL HANGER RODS:

Threaded both ends, threaded one end, or continuous threaded, black finish.

Size rods for individual hangers and trapeze support as indicated in the following schedule.

Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2

Provide rods complete with adjusting and lock nuts.

### WOOD STRUCTURE SUPPORTS

Carbon steel pipe short strap for piping 1/2" through 2". Fastened with two No. 24 x 2 (minimum size) wood screws. Anvil Figure 262.

Carbon steel coach screw rods machine threaded on opposite ends, minimum 3/8" diameter . Anvil Figure 142.

Carbon steel side beam bracket with minimum 3/8" rod size and fastened with minimum 1/2" x 3" lag screws. Anvil Figure 207

### PART 3 - EXECUTION

#### INSTALLATION

Install supports to provide for free expansion of the piping and duct system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.

Piping shall be supported independently from ductwork and all other trades.

Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes for the supporting steel.

#### HANGER AND SUPPORT SPACING

Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.

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

Support riser piping independently of connected horizontal piping.

Adjust hangers to obtain the slope specified in the piping section of this specification.

Space hangers for pipe as follows:

Pipe Material	Pipe Size	Max. Spacing
Steel	1/2" through 1-1/4"	6'-6"
Steel	1-1/2" through 6"	10'-0"
Thermoplastic	All sizes	6'-0"
Copper	1/2" through 1-1/4"	5'-0"
Copper	1-1/2" and larger	8'-0"

END OF SECTION



**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**  
**PART 1 - GENERAL**

**SCOPE**

This section includes air and water testing, adjusting and balancing for the entire project. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Description
- Pre-Installation Meeting and Scheduling
- Submittals

**PART 2 - PRODUCTS**

- Instrumentation

**PART 3 - EXECUTION**

- Preliminary Procedures
- Performing Testing, Adjusting and Balancing
- Deficiencies

**RELATED WORK**

Section 23 05 00 Common Work Results for HVAC  
Section 23 07 00 HVAC Insulation  
Section 23 09 14 Electric Instrumentation and Control Devices for HVAC

**REFERENCE**

Applicable provisions of the General Conditions, Supplementary General Conditions and General Requirements in Division 1 govern work under this section.

**DESCRIPTION**

The Contractor will separately contract with an independent test and balance agency to perform all testing, adjusting, and balancing of air systems required for this project. Work related to the testing, adjusting, and balancing that must be performed by the installing mechanical contractor is specified in other section of these specifications.

Provide total mechanical systems testing, adjusting and balancing. Requirements include the balance of air distribution, adjustment of new systems and equipment to provide design requirements indicated on the drawings, electrical measurement and verification of performance of all mechanical equipment, all in accordance with standards published by AABC, NEBB, or TABB.

Test, adjust and balance all air systems so that each room and piece of equipment meets the design requirements indicated on the drawings and in the specifications.

Accomplish testing, adjusting and balancing work in a timely manner that allows partial occupancy of entire project in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.

Verify that provisions are being made to accomplish the specified testing, adjusting and balancing work. If problems are found, handle as specified in Part 3 under Deficiencies.

**QUALITY ASSURANCE**

**Qualifications**

An independent Firm specializing in the Testing and Balancing of HVAC systems for a minimum of 3 years. A Firm not engaged in the commerce of furnishing or providing equipment or material generally related to HVAC work other than that specifically related to installing Testing and Balancing components necessary for work in this section such as, but not limited to sheaves, pulleys, and balancing dampers.

A certified member of AABC or certified by NEBB or TABB in the specific area of work performed. Maintain certification for the entire duration of the project.

## PRE-INSTALLATION MEETING AND SCHEDULING

The test and balance agency is required to attend a pre-installation meeting with all other project contractors before the construction process is started. The test and balance agency shall give the Mechanical Contractor a detailed schedule of testing and balancing tasks for incorporation into the project schedule.

## SUBMITTALS

See also Related Work in this section.

Submit testing, adjusting and balancing reports bearing the seal and signature of the NEBB, AABC or TABB Certified Test and Balance Supervisor. The reports certify that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.

### Submission:

Distribute electronic copies of the Report to the Contractor and the A/E.  
Enter a RFI, requesting review of the report.

Format: Cover page identifying project name, project number and descriptive title of contents. Divide the contents of the report into the below listed divisions:

- General Information
- Summary
- Air Systems

Contents: Provide the following minimum information, forms and data:

General Information: Inside cover sheet identifying Test and Balance Agency, Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.

Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.

The remainder of the report to contain the appropriate standard NEBB, AABC, or TABB forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate same.

## PART 2 - PRODUCTS

### INSTRUMENTATION

Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB, AABC, or TABB Standards and instrument manufacturer's specifications.

All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by DD upon request. Calibration and maintenance of all instruments to be in accordance with the requirements of NEBB, AABC, or TABB Standards

## PART 3 - EXECUTION

### PRELIMINARY PROCEDURES

Review applicable construction bulletins, applicable change orders and approved shop drawings of equipment, outlets/inlets and temperature controls.

Check filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and DX systems for proper charge and purging of air.

## **PERFORMING TESTING, ADJUSTING AND BALANCING**

Perform testing, adjusting and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards except as may be modified below.

In areas containing ceilings, remove ceiling tile to accomplish balancing work; replace tile when work is complete and provide new tile for any tile that are damaged by this procedure. If the ceiling construction is such that access panels are required for the work of this section and the panels have not been provided, inform the General Contractor.

Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.

Measure and record system measurements at the fan to determine total flow. Adjust equipment as required to yield specified total flow at terminals. Proceed taking measurements in mains and branches as required for final terminal balancing. Perform terminal balancing to specified flows balancing branch dampers, deflectors, extractors and valves prior to adjustment of terminals.

Measure and record static air pressure conditions across fans, coils and filters where reasonably accessible on packaged equipment. Indicate in report if cooling coil measurements were made on a wet or dry coil and if filter measurements were made on a clean or dirty filter.

Adjust outside air and return air dampers for design conditions and record data.

Adjust register, grille and diffuser vanes and accessories to achieve proper air distribution patterns and uniform space temperatures free from objectionable noise and drafts within the capabilities of the installed system.

Final air system measurements to be within the following range of specified cfm:

Fans	0% to +10%
Supply grilles, registers, diffusers	0% to +10%
Return/exhaust grilles, registers	0% to -10%

Contact the Contractor for assistance in operation and adjustment of controls during testing, adjusting and balancing procedures. Cycle controls and verify proper operation and setpoints. Include in report description of temperature control operation and any deficiencies found.

Permanently mark equipment settings, including damper positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.

Leave systems in proper working order, replacing belt guards, closing access doors and electrical boxes, and restoring temperature controls to normal operating settings.

## **DEFICIENCIES**

Division 23 00 00 contractor to correct any installation deficiencies found by the test and balance agency that were specified and/or shown on the Contract Documents to be performed as part of that division of work. Test and balance agency will notify the A/E of these items and instructions will be issued to the Division 23 00 00 contractor for correction of the deficient work.

END OF SECTION





**SECTION 23 07 00**  
**HVAC INSULATION**

**PART 1 - GENERAL**

**SCOPE**

This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Quality Assurance
- Description
- Definitions
- Shop Drawings
- Operation and Maintenance Data
- Environmental Requirements

**PART 2 - PRODUCTS**

- Materials
- Insulation Types
- Adhesives, Mastics, Sealants, and Reinforcing Materials Jackets
- Insulation Inserts and Pipe Shields
- Accessories

**PART 3 - EXECUTION**

- Examination
- Installation
- Protective Jacket Installation
- Piping, Valve and Fitting Insulation
- Piping Protective Jackets
- Pipe Insulation Schedule
- Duct Insulation
- Ductwork Protective Coverings
- Duct Insulation Schedule

**RELATED WORK**

Section 23 05 00 - Common Work Results for HVAC  
Section 23 11 00 - Facility Fuel Piping  
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment  
Section 23 31 00 - HVAC Ducts and Casings

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**QUALITY ASSURANCE**

Refer to division 1, General Conditions, Equals and Substitutions

Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

Insulation systems shall be applied by experienced contractors. Within the past five (5) years, the contractor shall be able to document the successful completion of a minimum of three (3) projects of at least 50% of the size and similar scope of the work specified in this section.

**DESCRIPTION**

Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:

- Pipe Insulation
- Duct Insulation

Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions.

## **DEFINITIONS**

Concealed: furred spaces, space above finished ceilings. All other areas shall be considered as exposed.

## **SHOP DRAWINGS**

Refer to division 1, General Conditions, Submittals.

Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

## **OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

## **ENVIRONMENTAL REQUIREMENTS**

Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.

Protect installed insulation work with plastic sheeting to prevent water damage.

# **PART 2 - PRODUCTS**

## **MATERIALS**

Manufacturers: Armacell, CertainTeed, Manson, Childers, Dow, Extol, Fibrex, Halstead, Foster, Imcoa, Johns Manville, Knauf, Owens-Corning, , Pittsburgh Corning, , VentureTape or approved equal.

Materials or accessories containing asbestos will not be accepted.

Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:

Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

## **INSULATION TYPES**

Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.

### **FLEXIBLE FIBERGLASS INSULATION:**

Minimum nominal density of 0.75 lbs. per cu. ft., and thermal conductivity of not more than 0.30 at 75 degrees F, rated for service to 250 degrees F.

### **RIGID FIBERGLASS INSULATION:**

Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, 0.25 at 125 degrees F, 0.27 at 150 degrees F, 0.29 at 200 degrees F, 0.32 at 250 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.

### **ELASTOMERIC INSULATION:**

Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 degrees F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment.

## **ADHESIVES, MASTIC, SEALANTS, AND REINFORCING MATERIALS**

Products shall be compatible with surfaces and materials on which they are applied, and shall be suitable for use at operating temperatures of systems to which they are applied.

### **FIBERGLASS INSULATION ADHESIVE:**

Must comply with ASTM C916, Type II: Foster 85-60, Childers CP-127, Duro Dyne SSG.

**VAPOR RETARDING MASTIC:**

Below ambient equipment/piping insulation, mastic water vapor permeance shall be less than 0.03 perms at 45 mils dry film thickness per ASTM E 96: Foster 30-65 Vapor Fas, Childers CP-34, Vimasco 749.

Below ambient equipment/piping, mastic must be anti-fungal and shall meet ASTM D 5590 with 0 growth rating (AF), water vapor permeance shall be less than 0.013 perms at 43 mils dry film thickness per ASTM E 96 Procedure B: Foster 30-80AF Vapor Safe Mastic or equal.

**WEATHER BARRIER BREATHER MASTIC:**

Above ambient equipment/piping, permeance shall be greater than 1.0 perms at 1/16" dry film thickness per ASTM E96. Foster 46-50 Weatherite, Childers Vi-Cryl CP-10/CP-11, Vimasco WC-5.

**LAGGING ADHESIVE / COATINGS:**

Indoors applications used in conjunction with canvas/glass cloth: Foster 30-36, Childers CP-50 AMV1, Vimasco 713.

For all indoor applications, coating must be anti-fungal and shall meet ASTM D 5590 with 0 growth rating (AF): Foster 30-36 AF Seal Fas, Childers CP-137 AF Chil-Seal.

**REINFORCING MESH:**

Foster 42-24 Mast A Fab, Childers Chil Glas #10 or Pittsburgh Corning PC 79.

**METAL JACKETING SEALANT FOR ALL ALUMINUM JACKETING:**

Foster 95-44 Elastolar, Childers CP-76 Chil-Byl, Pittsburgh Corning 727.

**INSULATION JOINT SEALANT: (cellular glass, polyisocyanurate, phenolic)**

Used on all below ambient piping to prevent moisture ingress. Foster 95-50 Flextra, Childers CP-76 Chil-Byl, Pittsburgh Corning CW Sealant.

**JACKETS**

**PVC FITTING COVERS AND JACKETS (PFJ):**

White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum .02" indoors/.03" outdoors for piping 12" and smaller, .03" indoors/.04" outdoors for piping 15" and larger.

**PROTECTIVE METAL JACKETS (PMJ):**

0.016 inch thick aluminum or 0.010 inch thick stainless steel with safety edge for indoor installations and 0.024 inch thick aluminum or 0.016 inch thick stainless steel with safety edge for outdoor installations.

**SELF-ADHERING JACKETS (SAJ):**

5-ply, self-adhering multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and cold weather acrylic adhesive providing zero (0.0) permeance. Minimum 6 mils material thickness, 25lb puncture resistance when tested in accordance with ASTM D1000 and flame spread/smoke developed rating of 10/20 when tested in accordance with UL 723.

Vapor retarding tape shall be specifically designed and manufactured for use with the self-adhering jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with self-adhering jackets shall have a maximum permeance of 0.0 perms.

**FABRIC REINFORCED MASTIC JACKETS (FMJ):**

Glass fiber reinforcing fabric imbedded in weather barrier mastic as per manufacturer's recommended procedure for 2 coat application.

**INSULATION INSERTS AND PIPE SHIELDS**

Manufacturers: B-Line, Pipe Shields, Value Engineered Products.

Construct inserts with calcium silicate or polyisocyanurate (service temperatures below 300 degrees F only), minimum 140 psi compressive strength. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping.

Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered/premanufactured product described above. On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.

Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x6" block for piping through 2-1/2" and three 1"x6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/premanufactured product described above.

Wood blocks will not be accepted.

#### **ACCESSORIES**

All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.

Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.

Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be 0.015 inch for aluminum and 0.010 inch for stainless steel.

Tack fasteners to be stainless steel ring grooved shank tacks.

Staples to be clinch style.

Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

Finishing cement to be ASTM C449.

Fibrous glass or canvas fabric reinforcing used with lagging adhesive shall have a minimum untreated weight of 6 oz./sq. yd.

Joint sealants and metal jacketing sealants to be non-shrinking and permanently flexible.

Vapor retarding coatings to have maximum applied water vapor permeance of 0.03 perms or less at 45 °F, dry as tested by ASTM E96.

Fungicidal water base duct liner coating (Foster 40-20 or equal) to be compatible with vapor retarding coating. This product must be EPA registered to be used inside HVAC ducts. Coating must comply with ASTM D 5590 with 0 growth rating.

### **PART 3 - EXECUTION**

#### **EXAMINATION**

Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.

Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

#### **INSTALLATION**

All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations. Surfaces to be insulated must be clean and dry.

Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

1 Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted.  
2 Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where  
3 insulation terminates.

4  
5 Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.

6  
7 Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces  
8 cut undersize and stretched to fit will not be accepted.

9  
10 All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except  
11 where firestop or firesafing materials are required. Vapor retarding jacket shall be maintained continuous through all  
12 penetrations.

13  
14 Provide a continuous unbroken moisture vapor retarding jacket on insulation applied to systems noted below.  
15 Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.

16  
17 Provide a complete vapor retarding jacket for insulation on the following systems:

18 Refrigerant

19 Insulated Duct

## 20 21 **PROTECTIVE JACKET INSTALLATION**

### 22 **PVC FITTING COVERS AND JACKETS (PFJ):**

23 Lap seams and joints a minimum of 2 inches and continuously seal PVC with welding solvent recommended by  
24 jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction.  
25 For sections where vapor retarding jacket is not required and jacket requires routine removal, tack fasteners may be  
26 used. Secure PVC fitting covers with tack fasteners. For systems requiring a vapor retarding jacket, apply a 1-1/2"  
27 band of mastic over ends, throat, seams and penetrations.

### 28 29 **PROTECTIVE METAL JACKET (PMJ):**

30 Lap seams a minimum of 2 inches. Secure with metal bands for end to end joints, and rivets or sheet metal screws  
31 for longitudinal joints. Rivets, screws, and bands to be constructed of the same material as the jacket. Locate seams  
32 on bottom for exterior applications. Seal laps with 1/8" bead of metal jacketing sealant to prevent water entry.

### 33 34 **SELF-ADHERING JACKETS (SAJ):**

35 Install according to manufacturer's recommendations. Cut allowing minimum 4" overlap on ends and 6" on  
36 longitudinal joints. Align parallel to surface. Remove release paper and press flat to surface to avoid wrinkles. Rub  
37 entire surface for full adhesion and sealing at joint overlaps. On exterior applications, provide a bead of compatible  
38 caulk along exposed edges.

39  
40 Piping with self-adhering (SAJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of  
41 vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the self-adhering (SAJ) jacket may be provided  
42 with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor  
43 retarding tape shall be compatible with the jacket material used.

### 44 45 **FABRIC REINFORCED MASTIC JACKETS (FMJ):**

46 Glass fiber fabric shall be fitted without wrinkles. Glass fiber fabric shall be sized immediately upon application  
47 with lagging adhesive and shall be capable of drying within 6 hrs. Apply adhesive and coating in accordance with  
48 manufacturer's recommendations. All seams shall overlap not less than 2".

## 49 50 **PIPING, VALVE, AND FITTING INSULATION**

### 51 **GENERAL:**

52 Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams  
53 and 2" tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally secure with  
54 staples along seams and butt joints.

55  
56 On systems requiring a vapor retarding jacket, seal off all raw ends of insulation and butt joints with vapor retarding  
57 mastic at intervals of not more than 20 feet on piping. Coat staples, longitudinal and transverse seams with vapor  
58 retarding mastic and on systems requiring vapor retarding jacket, coat insulated elbows, fittings, and valves with  
59 vapor retarding mastic.

60  
61 Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of  
62 insulation. Where a vapor retarding jacket is not required or where roller hangers are not being used, hangers and  
63 supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed

at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor retarding jacket, extend insulation and vapor retarding jacketing/coating around riser clamp.

Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.

#### INSULATION INSERTS AND PIPE SHIELDS:

Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer's installation instructions, however the inserts shall be no less than 12" in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.

Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

#### FITTINGS AND VALVES:

Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperatures do not exceed 150 degrees, furnish and install PVC fitting covers.

#### MINERAL FIBER:

Secure each 3' section with three metal bands snip off excess and turn ends over into insulation to prevent exposed sharp edges. Stagger joints where more than one layer is used.

#### ELASTOMERIC AND POLYOLEFIN:

Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40 degrees F with vapor retarding mastic.

#### PIPING PROTECTIVE JACKETS

In addition to the jackets specified in the pipe insulation schedule below the following protective jackets are required:

Provide a protective PVC jacket (PFJ) for the following insulated piping:  
Piping exposed in finished locations

Provide a protective PVC (PFJ) or Fabric Reinforced Mastic (FMJ) jacket for the following insulated piping:  
All piping within mechanical rooms.

Provide a protective metal (PMJ) or self-adhering (SAJ) jacket for the following insulated piping:  
Exterior installed refrigeration piping.

#### PIPE INSULATION SCHEDULE:

Provide insulation on new and existing remodeled piping as indicated in the following schedule:

SERVICE	INSULATION	JACKET	INSULATION THICKNESS BY PIPE SIZE				
			< 1"	1" to < 1-1/2"	1-1/2" to < 4"	4" to < 8"	8" and Larger
Cooling Coil Condensate Drain	Rigid Fiberglass	ASJ	0.5"	0.5"	1"	1"	1"
Refrigerant Piping	Elastomeric	PMJ or SAJ	0.5"	1"	1"	1"	1.5"

#### DUCT INSULATION

**GENERAL:**

Secure flexible duct insulation on sides and bottom of ductwork over 24" wide and all rigid duct insulation with weld pins. Space fasteners 18" on center or less as required to prevent sagging.

Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted as close as possible to the equipment surface. Pins shall be located a maximum of 3" from each edge and spaced no greater than 12" on center.

Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4" tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed with vapor retarding mastic.

Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.

External supply duct insulation is not required where ductwork contains continuous 1" acoustical liner. Provide 4" overlap of external insulation over ends of acoustically lined sections.

Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.

Where insulated duct risers are supported by steel channels secured directly to the duct, extend the insulation and vapor retarding jacketing to encapsulate the support channels.

**DUCTWORK PROTECTIVE COVERINGS:**

In addition to the jackets specified in the duct insulation schedule below the following protective coverings are required:

**DUCT INSULATION SCHEDULE:**

Provide duct insulation on new and existing remodeled ductwork in the following schedule:

SERVICE	INSULATION TYPE	JACKET	THICKNESS
Outside air ducts	Rigid Fiberglass	FSJ	2"
Mixed air ducts	Rigid Fiberglass	FSJ	2"
Exposed supply ducts*	Rigid Fiberglass	FSJ	2"
Concealed supply ducts	Flexible Fiberglass	FSJ	1-1/2"
Exhaust and relief ducts downstream of motorized backdraft dampers	Rigid Fiberglass	FSJ	2"
Louver blank-off panels	Rigid Fiberglass	FSJ	2"

\* Exposed supply branch ducts located in the space they are serving do not require insulation. Exposed supply main ducts running through spaces they serve shall be insulated as exposed supply ducts scheduled above.

END OF SECTION





**SECTION 23 09 14**  
**ELECTRIC INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

**PART 1 - GENERAL**

**SCOPE**

This sections includes pneumatic control system specifications for all HVAC work as well as related pneumatic control for systems found in other specification sections. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Work Not Included
- Quality Assurance
- System Description
- Submittals
- Design Criteria
- Operation and Maintenance Data
- Material Delivery and Storage

**PART 2 - PRODUCTS**

- Control Dampers
- Control System Instrumentation
- Electric/Electronic Thermostats
- Time Clocks
- Power Supplies

**PART 3 - EXECUTION**

- Installation
- Control System Instrumentation
- Room Thermostats and Temperature Sensors

**RELATED WORK**

Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination

Section 23 09 93 - Sequence of Operation

Section 23 33 00 - Ductwork Accessories - for control damper installation

Division 23 - HVAC - Equipment provided to be controlled or monitored

Division 26 - Electrical - Installation requirements & Equipment provided to be controlled or monitored

Division 28 - Electronic Safety and Security

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**SYSTEM DESCRIPTION**

System is to be electric/electronic.

**SUBMITTALS**

Include the following information:

Manufacturer's data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.

Schematic flow diagrams of systems showing dampers and other control devices. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.

Include on drawings location of mechanical equipment controlled (room number), horsepower and flow of motorized equipment (when this data is available on plans), locations of all remote sensors and control devices (either by room number or column lines).

Schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.

Prior to request for final payment, submit record documents which accurately record actual location of control components including thermostats, wiring, and sensors. Incorporate changes required during installation and start-up.

#### **DESIGN CRITERIA**

Size all control apparatus to properly supply and/or operate and control the apparatus served.

Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.

Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.

Use only UL labeled products that comply with NEMA Standards. Electrical components and installation to meet all requirements of the electrical sections (Division 26) of project specifications.

#### **OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

#### **MATERIAL DELIVERY AND STORAGE**

Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

## **PART 2 - PRODUCTS**

#### **CONTROL DAMPERS**

Provide control dampers shown on the plans and as required to perform the specified functions. Dampers shall be rated for velocities that will be encountered at maximum system design and rated for pressure equal or greater than the ductwork pressure class as specified in Section 23 31 00 of the ductwork where the damper is installed.

Use only factory fabricated dampers with mechanically captured replaceable resilient blade seals, stainless steel jamb seals and with entire assembly suitable for the maximum temperature and air velocities encountered in the system.

All dampers in aluminum ductwork shall be constructed of stainless steel or aluminum.

Dampers in galvanized ductwork shall be constructed of galvanized steel and/or aluminum.

All dampers, unless otherwise specified, to be rated at a minimum of 180° F working temperature. Leakage testing shall be certified to be based on latest edition of AMCA Standard 500-D and all dampers, unless otherwise specified, shall have leakage ratings as follows:

Damper Class	Differential Pressure	Leakage
Class IA	1" w.g.	≤3 CFM/ft <sup>2</sup>
Class I	4" w.g.	≤8 CFM/ft <sup>2</sup>

Leakage rate dampers for differential pressures that they will encounter at maximum system design pressures.

Steel framed dampers: Nailor models 2010 & 2020; Greenheck models VCD-33 & VCD-42; Johnson Controls model V-1330; Ruskin Models CD60 & CD40; other approved equal.

Aluminum frame and blade dampers: Nailor models 2010EAF & 202EAF; Greenheck model VCD-43; Ruskin model CD50; Arrow model AFD-20; other approved equal.

Dampers serving ambulance garage shall be thermally insulated control dampers with silicone side seals and EPDM blade seals.

Dampers used for isolation on the discharge of centrifugal fans shall have damper blades perpendicular to the fan shaft to minimize system effect. Dampers mounted with blades vertically shall be designed for vertical blade orientation.

Size operators for smooth and positive operation of devices served, and with sufficient torque capacity to provide tight shutoff against system temperatures and pressure encountered. For pneumatic actuation, use rolling diaphragm, piston type operators with adjustable stops. For electric modulating actuation, use fully proportional actuators with zero and span adjustments. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Equip operators with spring return or stored energy fail-safe return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Face and bypass dampers for heating applications shall fail to the face position.

All power required for electric actuation shall be provided by Electrical Contractor when it is 120V. All 24V power required for actuation shall be by this Contractor.

Provide operators with linkages and brackets for mounting on device served.

## **ELECTRIC/ELECTRONIC THERMOSTATS**

### **ELECTRIC THERMOSTATS:**

For single setpoint applications, provide line or low voltage electric type suitable for heating or heating and cooling as required. Provide the required number of heating and/or cooling stages required for the application. For line voltage ventilation applications utilizing fans and where otherwise specified in the sequence of operations, provide an integral manual On/Off/Auto selector switch. Minimum contact rating shall be equal or greater to electrical load of device being controlled.

Provide insulated subbase for all thermostats installed on outside walls, walls adjacent to vestibules or walls exposed to outside air temperatures. Subbase to provide a minimum of one half inch of insulation.

Line-voltage thermostats serve electric heaters. All other equipment shall have 24V thermostat (unless otherwise noted) to be wired by this contractor. Provide transformer when it is not provided by equipment manufacturer.

### **LOW VOLTAGE ELECTRONIC THERMOSTATS:**

Manufacturers: Honeywell, Johnson Controls, Viconics, or equal.

For furnaces, provide electronic programmable type with seven day setup/setback scheduling with a minimum of two occupied and unoccupied schedules per day through keypad entry on front of unit. For heating and cooling applications, provide automatic heating/cooling switchover.

Provide insulated subbase for all thermostats installed on outside walls, walls adjacent to vestibules or walls exposed to outside air temperatures. Subbase to provide a minimum of one half inch of insulation.

## **TIME CLOCKS**

Building occupancy time clocks, UL listed, digital, 7-day, minimum of 10 on/off programs per day, holiday programming, automatic daylight savings switchover, and minimum of seven-day battery back-up.

Garage ventilation time clock

UL listed, digital, 7-day, minimum of 24 on/off programs per day, automatic daylight savings switchover, and minimum of seven-day battery back-up.

## **TEMPERATURE CONTROL PANELS**

Constructed of steel or extruded aluminum, with hinged door, keyed lock, and baked enamel finish. Install controls, relays, transducers and automatic switches inside panels. Label devices with permanent printed labels and provide asbuilt wiring/piping diagram within enclosure. Provide raceways for wiring and poly within panel for neat appearance. Provide termination blocks for all wiring terminations. Label outside of panel with building system(s) served.

Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel.

## **CARBON MONOXIDE (CO) SENSOR**

Provide a Carbon Monoxide (CO) sensor that shall be a metal oxide semiconductor sensor which meets OSHA Standard 1910.100. Sensor shall be microprocessor based with temperature and humidity compensation. The sensor

shall be powered by low voltage. The monitor shall be housed in a NEMA 1 enclosure, which shall incorporate an alarm LED, status LED and audible alarm horn. The sensor shall have range of 0-250 ppm, analog output of 4 to 20mA over its range and user adjustable setpoint.

#### **NITROGEN DIOXIDE (NO2) SENSOR**

Provide a Nitrogen Dioxide (NO2) with an electrochemical sensing element. The sensor shall be powered by low voltage. The monitor shall be housed in a NEMA 1 enclosure, which shall incorporate an alarm LED, status LED and audible alarm horn. The sensor shall have a range of 0 to 10 ppm (parts per million), an analog output of 4 to 20mA over its range and user adjustable setpoint.

#### **POWER SUPPLIES**

Provide all required power supplies for transducers, sensors, transmitters and relays. All low voltage transformers shall have a resettable secondary circuit breaker and be listed as class 2 power supplies.

### **PART 3 - EXECUTION**

#### **INSTALLATION**

Install system with trained mechanics and electricians employed by the control equipment manufacturer or an authorized representative of the manufacturer. Where installing contractor is an authorized representative of the control manufacturer, such authorization shall have been in effect for a period of no less than three years.

Install all control equipment, accessories, wiring, and piping in a neat and workmanlike manner. All control devices must be installed in accessible locations. This contractor shall verify that all control devices furnished under this Section are functional and operating the mechanical equipment as specified.

Label all control devices with the exception of dampers with permanent printed labels that correspond to control drawings. Temperature control junction and pullboxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification.

All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This contractor shall coordinate with the insulation contractor to provide for continuous insulation of ductwork.

Mounting of electrical or electronic devices shall be protected from weather if the building is not completely enclosed. This Contractor shall be solely responsible for replacing any equipment that is damaged by water that infiltrates the building if equipment is installed prior to the building being enclosed.

Provide all electrical relays and wiring, line and low voltage, for control systems, devices and components. Install all low voltage wiring in metal conduit, Electrical Non-metallic Tubing (ENT), or Electrical Metallic Tubing (EMT), as scheduled below and hereafter referred to generically as conduit except above accessible ceilings as noted below. See Wire and Air Piping Conduit Installation Schedule below for specific conduit or tubing to be used. All raceways, enclosures, fittings and associated supports shall be provided and installed according to the requirements set forth in Division 16, NFPA 90 (NEC) and Chapter SPS 316 of the Wisconsin Administrative Code. All conduits shall be routed parallel and/or perpendicular to walls and adjacent piping. Raceways shall be located to maintain headroom and working clearance around equipment and devices that require inspection and service.

In general, support all raceways from the building structure. No component of a raceway system shall be secured to corrugated metal roof deck. Do not impose on the installations of other trades. Securing conduit, rods, straps, hangers, etc. to suspended ceiling components, electrical raceways, plumbing piping, fire protection sprinkler piping, HVAC piping or ductwork, or their associated support systems, will not be accepted.

Conduit shall be a minimum of 1/2 " for low voltage control provided the pipe fill does not exceed 40%.

Where HVAC equipment control panels, or devices, do not provide for the direct connection of conduits, exposed wiring may be extended to complete the final connections, providing it does not exceed 18 inches in length.

Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded.

Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations shall be in conduit. Wire for wall sensors shall be run in conduit. Wiring for radiation valves shall be run in conduit where routed through walls.

Where wiring is installed free-air, installation shall comply with the following:

- Wiring shall utilize the cable tray wherever possible.
- Wiring shall run at right angles and be kept clear of other trades work.
- Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
- At HVAC terminal units only, where the wiring serves a specific device; e.g. controller, actuator, transmitter, etc. associated with the unit, the j-hooks or Bridal rings required to support the wiring, may be secured to the rods or straps that support the ductwork or piping that serves the unit. Wall penetrations shall be sleeved.
- Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
- Wall penetrations shall be sleeved and fire stopped as specified.
- Wiring shall not be supported from existing cabling, existing tubing, plumbing or steam piping, ductwork, any component of a suspended ceiling, or electrical or communications conduit.

Install "hand/off/auto" selector switches on systems where automatic interlock controls are specified and "hand/off/auto" selector switches are not supplied with the equipment controlled. Control panel power will not be required for "hand" switch to operate. When switch is in "hand" position, allow manual operation of the selected device without operating the interlocked motors but allowing all unit safety devices to stay in the circuit.

#### **CONTROL DAMPERS**

All control dampers furnished by the control manufacturer are to be installed by the Mechanical Contractor and wired by Electrical Contractor in locations shown on plans or where required to provide specified sequence of control.

Coordinate installation with the sheetmetal installer to obtain smooth duct transitions where damper size is different than duct size. Blank off plates will not be accepted.

Each operator shall serve a maximum damper area of 36 square feet. Where larger dampers are used, provide multiple operators.

#### **ROOM THERMOSTATS AND TEMPERATURE SENSORS**

Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate room thermostats and sensors [48] inches above floor. Align with light switches and humidistats. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.

Any room thermostats or sensors mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one half inch of insulation.

Where thermostats or sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will effect the measurement.

Provide guards on thermostat serving gas-fired unit heater in ambulance garage.

120V line-voltage thermostat serving electric heaters are to be wired by electrician. Unless otherwise noted, all other thermostats are to be 24V and wired by this Contractor.

1 **TEMPERATURE CONTROL PANELS**

2 Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports.  
3 All control panel openings shall be plugged. Conduits and other penetrations on the top of the cabinets shall be  
4 sealed on the exterior of the cabinet with silicone caulk to resist water penetration. One cabinet may accommodate  
5 more than one system in same equipment room. Provide permanent printed labeling for instruments and controls  
6 inside cabinet and engraved plastic nameplates on cabinet face.

7  
8 Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of  
9 panel cover. Provide a protective cover or envelope for drawings.  
10  
11  
12  
13

END OF SECTION

**SECTION 23 09 23**  
**DIRECT DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 - GENERAL**

**1.01 SCOPE**

- A. Work in this section includes Direct Digital Control (DDC) panels, field equipment panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a complete, fully functional Direct Digital Control (DDC) building automation system, utilizing Direct Digital Control signals to meet, in every respect, all operational and quality standards specified herein.

**1.02 POINT CHARTS**

- A. Following this section.

**1.03 REFERENCE**

- A. Applicable provisions of Division 01 shall govern work under this section.

**1.04 RELATED WORK**

- A. Section 23 05 00 – Common Work Results for HVAC
- B. Section 23 05 15 – HVAC Valves and Piping Specialties
- C. Section 23 09 93 – Sequence of Operation for HVAC Controls
- D. Division 26 – Electrical

**1.05 WORK OF OTHER SECTIONS**

- A. Power wiring for starters.
- B. Furnishing of disconnect switches required by Code at motor locations.
- C. Installing and wiring motor starters.

**1.06 DEFINITIONS**

- A. The following definitions are applicable to work of this section:
  - 1. DDC Direct Digital Control
  - 2. BAS Building Automation System
  - 3. TCS Temperature Control System
  - 4. TCC Temperature Control Contractor
  - 5. I/O Input/output Device
  - 6. FMS Facility Management System
  - 7. LAN Local Area Network
  - 8. DCU Distributed Control Units
  - 9. ASC Application Specific Controller

**1.07 DESCRIPTION OF WORK**

- A. The extent of the work shall be as shown on the drawings, as shown in schedules and as detailed by the performance requirements specified hereinafter.

- B. All necessary software, hardware, firmware, operating equipment, devices and system components required for the system shall be provided by the Subcontractor whether or not specifically itemized, in order to provide a complete system within the intent of this specification.
- C. All system point types shall be universal I/O. All hardware inputs shall be digital inputs or analog inputs (field selectable). All hardware outputs shall be digital outputs or analog outputs (field selectable). Float control will not be allowed unless true analog feedback is used on a per point basis.
- D. It is the intent of this specification to describe a system utilizing the latest technology with an emphasis towards "connectivity". The BAS system shall in no way hinder the ability of the Owner to purchase mechanical equipment of multiple equipment manufacturers at this time or in the future.
- E. ALL exceptions to bid specifications shall be clearly listed with the BAS bid for Owner/Engineer review. ANY exceptions not listed shall bind the contractor to the full extent of the specifications. All questions and comments shall be directed in writing to the engineer.

#### **1.08 QUALITY ASSURANCE**

- A. Substitution of Materials: Refer to Division 01 and the General Conditions of the Contract, Article 3.
- B. MANUFACTURER
  - 1. Provide principal direct digital temperature control equipment and materials as manufactured by a single manufacturer.
- C. INSTALLER
  - 1. All work shall be installed by mechanics and technicians directly employed by the automatic control system manufacturer who shall be responsible for the proper installation and operation of the automatic control system.
  - 2. The Automatic Temperature Control Subcontractor shall maintain a local service office within a 75-mile radius of the job site, staffed with factory-trained engineers fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components.
  - 3. The Subcontractor shall have a five-year experience record in the design and installation of systems of similar design, manufacture and performance to the automatic temperature control systems specified herein.
- D. ELECTRICAL STANDARDS
  - 1. Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.
- E. DDC Standards
  - 1. DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (1979 Amendment to Part 15, Subpart J).

#### **1.09 SUBMITTALS**

- A. Submittals shall be required in two phases.
- B. First phase (approval) submittals



1. First phase (approval) submittals, to be done on AutoCAD, shall include job-tailored shop drawings as detailed herein, individual catalog cut sheets detailing manufacturer's data for each major control system component listed under Section 4, "Materials and Equipment", general catalog for all other minor control components and descriptive sequences detailing all automatic control system work. Generalized, standard catalog shop drawings shall not be used for first phase (approval) submittals. This Subcontractor shall develop a complete set of new shop drawings showing the entire automatic control system including the new digital automatic control system and the FMS system interface.
2. Each shop drawing shall be provided with a title block identifying the name of the project, the address of the project, the address of the Subcontractor, the shop drawing sheet number, the Subcontractor's in-house project identification number and the mechanical system reproof the latest revision made to the individual shop drawing.
3. Each mechanical system shall be represented by a line diagram showing each mechanical component (supply fans, heating coils, cooling coils, etc.) as well as any other mechanical system components present but not necessarily affected by the automatic control system (filters, etc.).
4. A line diagram representation of the respective mechanical system shall show all dampers in their relative locations (outside air ductwork, return air ductwork, etc.) and shall show all valves as they are intended to be connected to their respective mechanical component for proper operation.
5. A line diagram representation of the respective mechanical system shall also show all field-mounted automatic control system sensing and control components (sensors, transmitters, receiver-controllers, etc.) and all controlled devices (pressure-electric switches, electric-pressure solenoids, damper actuators, valve actuators, etc.).
6. All panel-mounted control components shall be shown within a separate section of the shop drawing designated for representation of the individual control panel and its face layout. Interconnecting pneumatic piping between panel-mounted components shall be shown. Interconnecting electrical wiring shall not be shown within the designated panel section of the shop drawing but shall be detailed in a one-line diagram (complete with terminal designations) on the same drawing.
7. All electrical wiring for starters of mechanical system components affected by the automatic control system (supply fans, exhaust fans, pumps, etc.) shall be represented as one-line diagrams showing all interlocks between the automatic control system, the respective starter and any other interlocks not necessarily provided as part of the automatic control system (fire alarm, smoke alarm, etc.).
8. Each shop drawing shall be accompanied by a typewritten listing identifying each control system component shown on that drawing. Each component shall be identified by the name used to designate the component on the shop drawings, the component's actual catalog description and designation (to be used when purchasing repair parts), the component's operating range, the component's fail-safe position, the component's setpoint (where applicable) and any other pertinent information.
9. Each shop drawing shall be accompanied by a typewritten sequence of operation identifying the designated function of each control component shown on that drawing. Each control component shall be identified in the sequence of operation by the name used to designate the component on the shop drawings.
10. Each sequence of operation detailing a control sequence involving more than one controlled device (damper operator, valve operator, etc.) shall be accompanied by a sequence graph identifying the relative position of the respective controlled device in the overall sequence (above and below the setpoint of the control loop controlling the respective device.)

11. First phase (approval) submittals shall be provided to and approved by the Owner's authorized representative before any job site installation work is performed.
- C. Second phase (operation and maintenance) submittals
  1. Second phase (operation and maintenance) submittals shall be provided after all installation, calibration and start-up work has been completed and shall include the first phase submittal shop drawings of the automatic control system, revised to reflect the system in its as-built condition, along with all information previously included in the first phase submittals.
  2. Each second phase (operation and maintenance) submittal shall include a typewritten set of operating instructions identifying the procedures to be employed to perform such automatic control system operations as overriding the system, entering new setpoints, displaying current values of system parameters, displaying trend logs, etc.
  3. Second phase (operation and maintenance) submittals shall also include information detailing preventive maintenance to be performed by the Owner on a regular basis and the Subcontractor's system guarantee and system component warranties.
  4. All as-builts shall be on AutoCAD and both a hard copy and 3.5" disk shall be included with O&M manuals.

#### 1.10 OPERATOR INSTRUCTION

- A. During the commissioning phase of the BAS/TCS installation and at such time as acceptable performance of the overall system's hardware and software has been established, the BAS/TCS Subcontractor shall provide on-site operator instruction to the Owner's operating personnel.
- B. On-site operator instruction shall be provided during normal working hours and shall be performed by competent representatives of the BAS/TCS Subcontractor familiar with the overall BAS/TCS software, hardware and accessories.
- C. At a time mutually agreed upon during the BAS/TCS commissioning phase as stated above, the BAS/TCS Subcontractor **shall provide 4 hours** of instruction to the Owner's designated personnel on the operation of all equipment within the BAS/TCS, describing its intended use with respect to the programmed functions specified.
- D. On-site operator instruction relevant to the BAS/TCS shall include, but not be limited to the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate operator intervention required in responding to the BAS/TCS operation, a description of the chronological information flow from field sensors, contacts and devices to the BAS/TCS and an overview of the BAS/TCS communication network explaining the interplay between initiating devices, field data-gathering panels, system communications and their importance within the operating system.
- E. Additional instruction time as deemed necessary by the Owner shall be obtained from the BAS/TCS Subcontractor on a negotiated basis with the Owner.
- F. Provide at the time of instruction, three copies of the Owner's operation and maintenance manual, custom-prepared for this project by the BAS/TCS Subcontractor, which shall be used in conjunction with the instruction. Each copy of the Owner's manual shall be bound in a three-ring binder, labeled with the name and address of the project.

### **1.11 MATERIAL DELIVERY AND STORAGE**

- A. Provide factory-shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

## **PART 2 - PRODUCTS**

### **2.01 APPROVED MANUFACTURERS**

- A. Johnson Controls, Inc., Metasys (Wisconsin Area Office), Staefa, Automated Logic, Siemens Building Technologies, Siebie, or TAC controls (represented by Kain Energy Corporation).

### **2.02 FACILITY MANAGEMENT SYSTEM**

- A. The FMS shall be a complete system designed for use on Intranets and the Internet. This functionality shall extend into the equipment rooms. Primary nodes located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure existing in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the FMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the FMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser such as Internet Explorer or Netscape.
- C. Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for archiving system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft Data Engine (MSDE) or Microsoft SQL Server as dictated elsewhere in this specification.
- D. The work of the single FMS Contractor shall be as defined individually and collectively in all Sections of this Division specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents as are listed in Part 1 of this Section.
- E. The FMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items as Specified in these Division documents which are required for the complete, fully functional and commissioned FMS.
- F. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software and configurations to be provided for this Project.
- G. Manage and coordinate the FMS work in a timely manner in consideration of the Project schedules. Coordinate cooperatively with the associated work of other

trades so as to assist the progress and not impede or delay the work of associated trades.

- H. The FMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
  - 1. Operator information, alarm management and control functions at any Operator's console without the need to purchase special software from the FMS manufacturer for those consoles.
  - 2. Enterprise-level information and control functions.
  - 3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
  - 4. Diagnostic monitoring and reporting of FMS functions.
  - 5. Offsite monitoring and management
  - 6. Energy management
  - 7. Indoor Air Quality monitoring and control

## **2.03 FMS ARCHITECTURE**

- A. OVERALL CONCEPTUAL DESCRIPTION
  - 1. The FMS shall be designed entirely for use on intranets and internets. All networking technology used at the Tier 1 level shall be off the shelf, industry standard technology fully compatible with other owner provided networks in the facility.
  - 2. All aspects of the user interface, whether to servers or to Tier 1 solid-state devices, shall be via browsers. Any PCs used as operator interface points shall not require the purchase of any special software from the manufacturer in order to provide the complete user interface as described herein.
  - 3. The user interface will be complete as described herein, providing complete tool sets, operational features, multi-panel displays, and other display features. Systems which merely provide HTML based web pages as the operator interface will not be acceptable.
  - 4. The primary components of the system will be the Primary Application Nodes and Servers located at the highest level of the network architecture. Both will use the same user interface and provide the same level of accessibility via the network. The only distinction between the user interface used on servers as compared to Primary Application Nodes will be select menu items used for accessing long term storage features on the servers or on their respective archive devices (CD/RW, etc.)
- B. GENERAL
  - 1. The FMS shall consist of a number of Nodes and associated equipment connected by industry standard network practices. All communication between Nodes shall be by digital means only.
  - 2. The FMS network shall at minimum comprise of the following:
    - a. Operator PCs – fixed or portable.
    - b. Network processing, data storage and communication equipment including file servers.
    - c. Routers, bridges, switches, hubs, modems and like communications equipment.
    - d. Active processing Nodes including field panels.
    - e. Intelligent and addressable elements and end devices.
    - f. Third-party equipment interfaces.
    - g. Other components required for a complete and working FMS.
  - 3. All FMS features shall be accessible via Enterprise Intranet and Internet browser with equivalent FMS access control for user access.
  - 4. The FMS shall support auto-dial/auto-answer communications to allow FMS Nodes to communicate with other remote FMS Nodes via standard telephone lines. Refer to drawings for type of line to be used, DSL or

- voice grade. Where no preference is indicated, DSL is the preferred grade.
5. The PC Workstations, File servers and principal network equipment shall be standard products of recognized major manufacturers available through normal PC vendor channels. "Clones" are not acceptable.
  6. Provide licenses for all software residing in the FMS system and transfer these licenses to the Owner prior to completion.
- C. NETWORK
1. The FMS shall incorporate a primary Tier 1 network. At the Contractor's option, the FMS may also incorporate integrated secondary Tier 2 and tertiary Tier 3 networks.
  2. The FMS Network shall utilize an open architecture capable of all of the following:
    - a. Utilizing standard Ethernet communications and operate at a minimum speed of 10/100 Mb/sec
    - b. Connecting via BACnet at the Tier 1 level in accordance with as per ANSI/ASHRAE Standard 135-2001.
    - c. Connecting via the N2 Protocol at the Tier 2 level.
    - d. Connecting via LonMark as per ANSI/EIA 709 (LonWorks) to LonMark FTT-10 transceivers at the Tier 2 level.
  3. The FMS network shall support both copper and optical fiber communication media.

#### **2.04 THIRD-PARTY INTERFACES**

- A. FMS Contractor shall integrate real-time data from systems supplied by other trades as required in Part 3.
1. The FMS system shall include necessary FMS hardware equipment and software to allow data communications between the FMS system and systems supplied by other trades.
  2. The trade contractor supplying other systems will provide their necessary hardware and software and will cooperate fully with the FMS contractor in a timely manner at their cost to ensure complete data integration.

#### **2.05 UNINTERRUPTIBLE POWER SUPPLY (UPS)**

- A. Where indicated for supporting operator PCs, servers, and other equipment as indicated, provide a UPS.
- B. UPS shall be sized for 50% spare capacity. The UPS shall be complete with batteries, external bypass and line conditioning.

#### **2.06 POWER FAIL/AUTO RESTART**

- A. Provide for the automatic orderly and predefined shutdown of parts or all of the FMS following total loss of power to parts or all of the FMS.
- B. Provide for the automatic orderly and predefined startup of parts or all of the FMS following total loss of power to those parts or all of the FMS. Archive and annunciate time and details of restoration.
- C. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.
- D. Maintain the FMS real-time clock operation during periods of power outage for a minimum of 72 hours.

## **2.07      DOWNLOADING AND UPLOADING**

- A. Provide the capability to generate FMS software-based sequences, database items and associated operational definition information and user-required revisions to same at any Operator PC, and the means to download same to the associated Application Node.
- B. Application software tool used for the generation of custom logic sequences shall be resident in both the application node and the server(s) where indicated on the drawings.
- C. Provide the capability to upload FMS operating software information, database items, sequences and alarms to the designated server(s).
- D. The functions of this Part shall be governed by the codes, approvals and regulations applying to each individual FMS application.
- E. OPERATOR PC'S
  - 1. The Operator PCs (PCs) shall provide the primary means of communication with the FMS and shall be used for operations, engineering, management, audit, reporting and other related functions.
  - 2. The PCs shall consist of fixed and portable units as scheduled in Part 3 of this Specification. The fixed units shall consist of installed PC-based configurations. The portable units shall consist of PC Laptop or similar designed unit, complete with keyboard or similar entry/selection device and complete with display and communication arrangements with ANs.
  - 3. Each fixed PC shall, at minimum, consist of:
    - a. Pentium PC processor with minimum 64-bit word structure, minimum 2 GHZ processor speed
    - b. 80 GB Hard drive
    - c. Minimum 1 gigabyte on board ram
    - d. Removable high-speed data storage and export device(s) such as Read/Write CD-ROM or equal.
    - e. Full ASCII keyboard and digital Mouse
    - f. Full color, flat screen VDU display unit, minimum 17 inches diagonal screen, minimum 1280 x 1024 resolution, 0.26 or better dot pitch and minimum 72 Hz refresh rate.
    - g. Inkjet color printer
    - h. OS shall be Windows 2000 Professional or Windows XP Professional
  - 4. All fixed PCs shall operate independently and concurrently without interference and under individual user password protection.
  - 5. PCs functionality shall be individually definable by software means such that PC may be designated for specific limited users and may also be readily re-designated to provide OWS back-up to other OWSs in the FMS.
  - 6. Portable PC shall operate identically to the fixed PC.
  - 7. Fixed or portable operator PCs shall not require any special software to be purchased from the FMS manufacturer. All actions required for the complete operator interface as described herein shall be accomplished through a common browser.

## **2.08      OPERATOR INTERFACE**

- A. GENERAL
  - 1. The FMS Operator Interface shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the FMS by authorized users at the OWS.

2. It shall be possible to designate any PC on the Tier 1 network as an Operator Interface point. No special software will need to be purchased from the FMS manufacturer for any such PC.
3. User access to the FMS shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level and partitionable to accommodate the varied access requirements of the different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to on-line manage password access control under the control of a Master Password.
4. The user interface shall be able to combine data from any and all of the system components in a single browser window. This shall include historical data stored on a server.
5. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
  - a. User access for selective information retrieval and control command execution
  - b. Monitoring and reporting
  - c. Alarm, non-normal, and return to normal condition annunciation
  - d. Selective operator override and other control actions
  - e. Information archiving, manipulation, formatting, display and reporting
  - f. FMS internal performance supervision and diagnostics
  - g. On-line access to user HELP menus
  - h. On-line access to current FMS as-built records and documentation
  - i. Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.
6. Provide FMS reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations and the like to assist user understanding and interpretation. All text naming conventions shall be consistent in their use and application throughout the FMS.
7. All PC-based configurations shall operate on Microsoft® Windows 2000 or Windows XP.
8. Each fixed and portable PC shall be on-line configurable for specific applications, functions and groups of FMS points.

**B. NAVIGATION TREES**

1. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
2. Provide the ability for the operator add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
3. The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

**C. DIVIDIBLE DISPLAY PANELS**

1. It shall be possible for the operator to divide the display area within a single browser window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided by the system.
  - 2.
  3. Provide each display panel with minimize, maximize, and close icons.
- D. ALARMS
1. Alarms shall be routed directly from primary application nodes to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the OWS software shall, at the minimum, provide the following functions:
    - a. Log date and time of alarm occurrence.
    - b. Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
    - c. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
    - d. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
    - e. Provide the ability to direct alarms to an e-mail address or alpha-numeric pager. This must be provided in addition to the pop up window described above. Systems which use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
    - f. Any attribute of any object in the system may be designated to report an alarm.
  2. The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
  3. The FMS shall annunciate application alarms at minimum, as required by Part 3.
- E. REPORTS
1. Reports shall be generated and directed to one or more of the following: User interface displays, printers, or archive at the user's option. As a minimum, the system shall provide the following reports:
    - a. All points in the FMS.
    - b. All points in each FMS application.
    - c. All points in a specific AN.
    - d. All points in a user-defined group of points.
    - e. All points currently in alarm in an FMS application.
    - f. All points locked out in an FMS application.
    - g. All FMS schedules.
    - h. All user defined and adjustable variables, schedules, interlocks and the like.
    - i. FMS diagnostic and system status reports.
  2. Provide all applicable standard reports of the FMS manufacturer.
  3. Provide for the generation by the user of custom reports as specified in Part 3.
- F. DYNAMIC COLOR GRAPHICS
1. An unlimited number of graphic displays shall be able to be generated and executed.
  2. Graphics shall be based on Scalar Vector Graphic (SVG) technology.
  3. Values of real time attributes displayed on the graphics shall be dynamic and updated on the displays.
  4. The graphic displays shall be able to display and provide animation based on real-time FMS data that is acquired, derived, or entered.



5. The user shall be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.
6. Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the AN.
7. FMS system shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent components of a typical FMS system. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.

**G. SCHEDULES**

1. The system shall provide multiple schedule input forms for automatic FMS time-of-day scheduling and override scheduling of FMS operations. At a minimum, the following spreadsheet types shall be accommodated:
  - a. Weekly schedules.
  - b. Temporary override schedules.
  - c. Special "Only Active If Today Is A Holiday" schedules.
  - d. Monthly schedules.
2. Schedules shall be provided for each system or sub-system in the FMS. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

**H. HISTORICAL TRENDING AND DATA COLLECTION**

1. Trend and store point history data for all FMS points and values as selected by the user.
2. The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.
3. At a minimum, provide the capability to perform statistical functions on the historical database:
  - a. Average.
  - b. Arithmetic mean.
  - c. Maximum/minimum values.
  - d. Range – difference between minimum and maximum values.
  - e. Standard deviation.
  - f. Sum of all values.
  - g. Variance.

**2.09 PAGING**

- A.** Provide the means of automatic alphanumeric paging of personnel for user-defined FMS events.
1. System shall support both numeric and alpha-numeric pagers, using Alphanumeric, PET, or IXO Protocol at the owner's option.
  2. Users shall have the ability to modify the phone number or message to be displayed on the pager through the system software.
  3. System shall utilize pager schedules to send pages to the personnel that are "on-call".
  4. Contractor shall be responsible for providing a modem for connection to the paging service.

## 2.10 APPLICATION NODES

### A. PRIMARY APPLICATION NODES

1. The primary application node shall perform the function of monitoring all system variables, both from real hardware points, software variables, and controller parameters such as setpoints.
2. Application nodes shall be entirely solid state devices. No rigid disk drives will be permitted in the equipment rooms.
3. The primary application nodes shall manage and direct all information traffic on the Tier 1 network, between the Tier 1 and Tier2 networks, and to servers.
4. Any node on the Tier 1 network shall be equipped with all software necessary to drive the complete user interface including graphics on a browser connected to the node via the network or directly via a local port on the node.
5. The operating system of the application node shall support multi-user access. At minimum four users shall be able to access the same application node simultaneously.
6. Communication between nodes shall be per-to-peer via 10/100 Ethernet using the BACnet protocol.
7. The AN shall be capable of direct connection to multiple field busses using different protocols simultaneously as indicated below. Should the controller not support multiple field busses, install two primary nodes side by side as follows:
  - a. RS-485 serial field bus such as MSTP or the manufacturer's proprietary field bus
  - b. LON field bus for supervision and control of LON based controllers that conform to the Lon Talk standard.
8. The primary nodes will integrate data from both field busses into a common object structure. Data from both field busses will appear in common displays throughout the user interface in exactly the same format. It shall not be possible to determine which field buss the data originated on without reviewing the system configuration data.
9. AN shall be programmable and governed by the requirements of their applicable codes, approvals and regulations.
10. The AN shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this Project.
11. A failure at an AN shall not cause failures or non-normal operation at any other system AN other than the possible loss of active real-time information from the failed AN.
12. Ancillary AN equipment, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.
13. AN shall comply with FCC Part 15 subpart J class A emission requirements.
14. Each primary node shall be equipped with the necessary un-interruptible power such that it will not cease operation during minor power outages, including those that occur upon transfer to emergency generator or other local power source not provided by the utility.

### B. HVAC NODE

1. HVAC Node shall provide both standalone and networked direct digital control of HVAC systems.
2. A dedicated HVAC Node shall be configured and provided for each primary HVAC system (air handler, chiller, boiler) and each terminal HVAC system (VAV Box, Unit Heater, Fan Coil Unit, Cabinet Heater, Heat Pump, Fan Powered Box, CV Box)

3. Each HVAC Node shall retain program, control algorithms, and setpoint information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.
4. Each HVAC Node shall report its communication status to the FMS. The FMS shall provide a system advisory upon communication failure and restoration.
5. For each primary HVAC system, provide means of indication of system performance and setpoints at, or adjacent to the HVAC Node.
6. For each primary HVAC system, provide a means to adjust setpoints and start/stop equipment at, or adjacent to the HVAC Node.
7. Provide a means to prevent unauthorized personnel from accessing setpoint adjustments and equipment control functions.
8. The HVAC Node shall provide the ability to download and upload configuration data, both locally at the Node and via the FMS communications network.
9. The HVAC Node shall be provided with a permanently-mounted local graphic terminal where required in the sequences of this specification. The local graphic terminal shall provide dynamic graphical representation of the associated system status, with the ability for the operator to enter commands with proper password protection.

## **2.11 APPLICATION SOFTWARE**

### **A. HVAC APPLICATION SOFTWARE**

1. Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined FMS real-time event including equipment/point status change, approaching limit or alarm, time of day and the like. Direct messages to any number of operator PCs, e-mail destinations, and pagers.
2. Indoor Air Quality: Provide monitoring of outside air, return air and supply air CO<sub>2</sub> concentration, calculate and maintain fresh air requirements. Adjust outdoor air intake to ensure return air CO<sub>2</sub> high level limit is not exceeded.
3. Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions, to determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.
4. Auto Alarm Lockout: Provide for scheduled and automatic lockout of alarm annunciation from equipment during non-normal operating conditions including shutdown, emergency power operation, fire alarm and the like.
5. Energy monitoring: Provide software to monitor and totalize consumption as measured by pulse meters.
6. Event Initiated Programs and custom logic: Provide software to define custom logic sequences that will reside in the nodes. The definition software will also reside in the node and be accessible via the standard user interface via a browser.
7. System Restart: Upon restoration of the AC power to an HVAC Node, automatically restart all equipment and restore all loads to the state as required by the FMS. Provide appropriate time delays to prevent demand surges or overload trips.
8. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

9. Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.
10. Analog/Pulse Totalization: Sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

## **2.12 FUNCTIONAL REQUIREMENTS**

### **A. APPLICATION SPECIFIC CONTROLLER INTERFACE**

1. It shall not be necessary to calculate and enter Proportional, Integral, Derivative, or Interval values in order to engineer, startup or commission the ASCs. The ASCs shall be shipped with default parameters which can be adjusted if required. Standard default parameters will be different for each application.

### **B. APPLICATION SPECIFIC CONTROLLER - COMMON REQUIREMENTS**

1. Inputs shall be software definable to accept Thermistor or Discrete Contact Closure. Outputs shall be TRIAC, and shall support Two Position, Frequency Modulated, Pulse Width Modulated and Floating.
2. Connectors for field wiring shall be easily removable without disconnecting the cabling.
3. LED indication shall be provided for communications status and controller self diagnostics status.
4. Setpoint bias, local override, and room temperature shall be available via the room sensor or a plain Thermistor based sensor, using the same terminals.
5. The room sensor shall support a hand held console
6. The ASC shall be UL Listed for UL 916 Energy Management Systems. Any plastics used (i.e., cover, etc.) shall be UL Listed for UL 94-V0 (self extinguishing materials).
7. The ASC shall be field configurable for standalone operation, without power to the unit, using DIP switches, or similar methods. The ASC shall operate with the new settings immediately and not require a power cycle to initiate them. Each ASC shall ship from the factory pre-programmed with common default values.
8. Editors, set points, addresses, etc. shall remain in NOVRAM or EEPROM, to ensure standalone operation. It shall be possible to read and write to this memory, locally and remotely to make changes to the default parameters. Parameters requiring ongoing changes will reside in RAM, and default to the NOVRAM or EEPROM values.
9. The ASC shall contain a seven day software clock which shall be accurate to five (5) minutes per day. This software clock is intended to be used for initial commissioning prior to connecting to the communication bus, as well as a "fallback" for when communication with the bus is lost. The hardware clock in the communication bus shall automatically update the software clocks in the ASC's once per day, to ensure best accuracy during occupancy hours.
10. Outside air sensor value will be available to all ASC's from a system point external to the ASC. Where the ASC uses the outside air temperature value (e.g.; economizer) and communication is lost with the source, the ASC will retain the last communicated value.
11. The ASCs shall support one-step calibration of temperature sensors and velocity transducers. Eliminate the need for a technician, test & balance contractor, or Owner to have to refer to look-up tables or to interpolate "counts" in calibration or recalibration of an input or output.
12. Staging will be automatic. If one stage is required, analog outputs will vary between 0 and 100% as the load calculation varies between 0 and 100%. If two stages are required, stage one analog output will vary between 0 and 100% as the load calculation varies between 0 and 50%, and stage

two analog output will vary between 0 and 100% as the load calculation varies between 50 and 100%. Digital outputs will also be staged and modulated using time proportioned modulation over a fixed window (i.e., 5 or 10 minutes). If one stage is required the first stage will be on for ¼ the time window for a 25% load calculation, ½ the time window for a 50% load calculation, etc. If two stages are required, the first stage will be on 100% at 50% load calculation, and the second stage will be on for ½ its time window at 75% load calculation.

13. The currently active zone temperature set points (as biased by setpoint adjustment) shall be available for dynamic displays, and use in other system applications.
14. Fans, compressors, heat stages, and the like shall have minimum on and maximum off times. It shall be possible to lockout heating and cooling centrally. Fans shall be interlocked to operate when stages of heat or cooling are operational.
15. Resident I/O database shall support minimum trip and close. Default minimum fan cycle times = 30 seconds and minimum compressor cycle time = 4 minutes. These values shall be adjustable.
16. Provide for points to be predefined based on how they are wired to certain terminals. For applications which do not fully utilize all points in an application, the unused point may be any defined for other applications resident in the MCI or other controllers..

C. AIR HANDLING UNIT (AHU) APPLICATION SPECIFIC CONTROLLER

1. The AHU ASC shall support single zone AHUs and fan coil units.
2. The Air Handling Unit controller shall maintain space temperature against heating and cooling set points, using two PID algorithms (heating & cooling). Selection of multiple stages of either, will auto-range the activation setpoints. For example, if one compressor and two stages of supplemental heat are selected, the compressor will come on for PID % (heating load) above zero %, heating stage #1 will come on at 34%, and heating stage #2 will come on at 67%. Supplemental heat may be modulated by time proportioning over its range. For example, with an 83% heating load, the compressor and heating stage #1 will be on continuously, and heating stage #2 will be on for one half of its time window (typically 20+ minutes - fixed).
3. Economizer - ASHRAE Cycle II, via Global Outside Air Temperature. The economizer shall lockout if outside air temperature is greater than a limit value (adjustable). Outside air damper may be two position or modulating. When an economizer is used, the lower half of the cooling control signal will be used to calculate (reset) the discharge air temperature set point between limit values (i.e. 53 to 73 degrees), and the outside air damper is modulated to maintain this set point.

## 2.13 TEMPERATURE SENSORS

- A. Provide thermistor or thin film silicon sensors for all temperature applications, except differential chilled water for BTU calculation, where precision matched Platinum RTDs shall be used. Solid-state sensors shall be linear, drift free, and require only a one-time calibration. Thermistors, or similar non-linear temperature devices shall be linearized by a look-up table in the connected controller. Resolution shall be better than 0.5 degrees F for zone or terminal equipment applications, and better than 0.2 degrees F for DDC control unit applications.

## 2.14 ROOM SENSORS (THERMOSTATS)

- A. Room thermostats shall be active DDC type space sensors/thermostats. Each thermostat shall have user setpoint adjustment and shall also have the capability

to digitally display room temperature and room temperature setpoint. The thermostat/sensor display shall present the midpoint of the heating and cooling set points for normal operation to avoid user confusion. The thermostat shall communicate with the DDC system for both room temperature and room temperature setpoint. The room temperature setpoint shall be remotely adjustable via the DDC system. User adjustment shall have the capability of being locked out if so desired via the DDC system.

- B. Room sensors shall have an adjustable deadband between heating and cooling points. Deadband range shall allow the sensor to be set with up to a 5°F deadband range.
- C. For special applications, provide remote mounted, or duct mounted sensors as indicated on the plans.
- D. Provide insulated subbase for all thermostats/sensors installed on outside walls or walls exposed to outside air temperatures.
- E. Thermistor type room thermostats are not acceptable.
- F. **INTELLIGENT SENSORS**
  - 1. Where shown on the plans, provide "intelligent" space sensors for Application Specific Controllers which have the following features:
    - a. 3 digit (plus decimal) alphanumeric display.
    - b. A means to locally controller analog or digital points in the connected controller.
    - c. Local override and setpoint adjustment (within software limits).
    - d. Occupancy status LED and On/Off push-button.
    - e. A "call" push-button that can be linked to an Event Initiated Program anywhere in the system.
    - f. Display of all local input and output points in the service mode for ASCs.
    - g. Display of up to 4 user defined "global" or system points (e.g., outside air temperature, outside air RH, fan status).
    - h. Password protection of access to service mode, with a selection of up to 1000 passwords for ASC.
  - 2. Space sensors shall have an integral port for connection of a portable "intelligent" sensor to communicate with its ASC. This port and portable "intelligent" sensor may be used for initiating the "test mode" locally to verify all ASC control sequences, and perform test and balancing functions. To eliminate the downtime associated with rechargeable batteries, the portable "intelligent" sensor shall receive its power from the sensor port.

## **2.15 CONTROL DAMPERS**

- A. Furnish control dampers shown on the plans and as required to perform the specified functions.
- B. Acceptable Manufacturers of air dampers are Ruskin model CD-36 or equivalent Johnson Controls, Air Balance, Advanced Air, Cesco, American Warming and Ventilating, Vent Products Company Inc., Greenheck or Arrow damper products.
- C. Use only factory fabricated, low leakage type dampers with replaceable resilient blade seals, stainless steel jamb seals and with entire assembly suitable for the maximum temperature and air velocities encountered in the system.
- D. All dampers for shut-off or isolation service to be UL 555S Class 2 leakage rated at 250°F.

- E. Dampers used for mixing of airstreams to be parallel blade type, sized for air velocity of 1800 to 2000 fpm. Dampers used for throttling or modulating applications other than air stream mixing to be opposed blade type. Two position dampers may be parallel or opposed blade type.
- F. Dampers for applications other than fume exhaust to have frames of not less than 16 gauge galvanized steel or 12 gauge extruded aluminum. Blades to be not less than 16 gauge galvanized steel for single thickness, 22 gauge galvanized steel for double thickness, or 14-gauge aluminum, with steel rod, bronze or nylon bearings. Maximum allowable blade width is 8 inches. Use zinc plated steel linkage hardware.
- G. Maximum damper width is 48 inches; where required width exceeds 48 inches, use multiple dampers. Minimum size for duct-mounted dampers is 90% of duct size.
- H. Damper operators shall be Belimo or Johnson Controls, Inc. electric type compatible with the DDC control system. Use direct mount, synchronized operating, bi-directional, fail-safe operators. Provide operators with linkages and brackets for mounting on device served as required.
- I. Size operators for smooth and positive operation of devices served, and with sufficient capacity to provide tight shutoff against system temperatures and pressure encountered. Equip operators with spring return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation.
- J. Provide operators with linkages and brackets for mounting on device served.

## 2.16 CONTROL VALVES

- A. Provide all control valves as shown on the plans/details and as required to perform functions specified.
- B. Control valves shall be Belimo, or approved equal.
- C. Valve operators shall be electric type compatible with the DDC control system. Use direct mount, synchronized operating, bi-directional, fail-safe operators. Provide operators with brackets for mounting on the valve served.
- D. Size operators to allow smooth and positive operation of devices served and to provide sufficient capacity for tight shutoff against system temperatures and pressure encountered.
- E. Use operators that are full-proportioning or two-position, as required for specified sequence of operation. Provide spring-return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation.
- F. Provide operators with linkages and brackets for mounting on the valve served.  
*Edit the following valve specifications as required for the specific project.*
- G. WATER SYSTEMS
  - 1. Use equal percentage valves for two-way control valves; size for a pressure drop not less than 2 PSIG nor more than 4 PSIG.
  - 2. Use three-way valves sized for a maximum pressure drop of 4 PSIG and that have linear characteristics so that the valve pressure drop remains constant regardless of the valve position.

3. Globe Valves 2" and Smaller: Bronze body, brass plug and seat, stainless steel stem, composition disc, spring loaded teflon packing, screwed ends, suitable for use on water systems at 150 PSIG and 240 F.
4. Globe Valves 2½" and Larger: Iron body, brass plug and seat, stainless steel stem, spring loaded teflon packing, flanged ends, suitable for use on water systems at 150 PSIG and 240°F.
5. Butterfly Valves 3" and Larger: Iron body, stainless steel shaft, bronze bearings, resilient seat. Disc to be aluminum-bronze, nickel-plated ductile iron, cast iron with welded nickel edge, or stainless steel. Valve assembly to be bubble tight, suitable for use on water systems at 150 PSIG and 240°F.

## **2.17 SPECIALTY THERMOSTATS**

- A. Provide insulated base for all thermostats installed on outside walls or walls exposed to outside air temperatures.
- B. **LOW VOLTAGE ROOM THERMOSTATS**
  1. These types are to be used for control of terminal units such as convectors, cabinet heaters, etc.
  2. Use direct or reverse acting as required. Temperature setpoint range shall be between 40 and 80 degrees F for heating thermostats, and 60 to 100 degrees F for thermostats controlling ventilation systems.
- C. **LINE VOLTAGE THERMOSTATS**
  1. These types are to be used for control of unit heaters, and ventilation fans as indicated.
  2. Use single or two pole, direct or reverse acting as required, with minimum rating equal to electrical load of device being controlled. Temperature setpoint range shall be between 40 and 80 degrees F for heating thermostats, and 60 to 100 degrees F for thermostats controlling ventilation systems.
- D. **LOW LIMIT THERMOSTATS (FREEZESTATS)**
  1. Provide low temperature protection thermostats of the manual-reset type with sensing elements 20' in length.
  2. Provide thermostat designed to operate in response to the coldest 1' - 0" length of the sensing element, regardless of the temperature at other parts of the element.
  3. Support the element properly to cover the entire duct width.
  4. Provide separate thermostats for each 25 square feet of coil face area or fraction thereof.
  5. Unless otherwise indicated, set low limit controls at 36 degrees F.
- E. **AQUASTATS**
  1. Line voltage type with single pole, single throw switch of adequate rating for the applied load.
- F. **DUCT THERMOSTATS**
  1. DDC Type: Sensing element to be averaging type, temperature compensated, armored, with minimum length of 8 feet.
- G. **IMMERSION TYPE TEMPERATURE SENSORS**
  1. Rod and Tube Type With Linear Output. Provide separable wells with heat conductive fluid for installation in pipeline. Units shall be factory calibrated.



## **2.18 AIR FLOW MEASURING STATIONS**

### **A. AIRFLOW PROBE**

1. Ebtron Series 3000 (or equivalent) multi-probe duct thermal anemometer station consisting of a duct mounted lattice work of heated flow sensing thermistors and temperature sensors mounted inside an aluminum casing. Each thermistor shall be mounted within a strut, protected from upstream flow with an aluminum air straitening tube protecting the sensor. Unit shall be capable of linear flow measurement down to 0 FPM velocity in the ductwork.
2. Airflow resistance shall be less than or equal to 0.01 inches of water at 2000 feet per minute air velocity. Station shall be suitable for a velocity range from 0-5000 FPM, with an accuracy of +/- 2% over the entire range. Sensor shall be suitable for use from 40°F to 160°F and 0%-99% R.H. (non-condensing).
3. A Series 4000 for mounting at the inlet to the supply/return fan is also acceptable as an option when sufficient ductwork space is not available for installation of a series 3000.

### **B. TRANSDUCER**

1. Micro-processor based electronics mounted in a NEMA 1 enclosure, suitable for indoor installation.
2. Each electronics panel shall be powered by an isolated (secondary not grounded) 24 VAC transformer or a regulated 24VAC power supply.
3. The transducer shall be capable of providing either a 4-20 mA or 0-10 VDC output for both airflow and temperature.

## **2.19 MISCELLANEOUS SENSORS**

### **A. TEMPERATURE SENSORS**

1. Use nickel wire thermistor type temperature sensing elements constructed so that the accuracy and life expectancy is not affected by moisture or other conditions that exist in each application. Normal range to be 35°F to 100°F with accuracy of  $\pm 0.5^\circ\text{F}$  and a base resistance of 1000 ohms at 77°F.
2. Provide limited range or extended range sensors if required to sense the range expected for a respective point.
3. Use averaging elements on duct sensors.
4. Use elements on sensors in piping systems compatible with installation in separable wells.

### **B. HUMIDITY SENSORS**

1. Use thin polymer film or composite organic/inorganic crystal types with a range of 0-100% RH. Accuracy to be no less than  $\pm 3\%$  in the range of 20% RH to 80% RH with a response time of 30 seconds or less.

### **C. Room sensors**

1. Wall mounted with adjustable 2% RH range. Provide sensors in occupied spaces with covers to match those specified for thermostats.

### **D. Duct Sensors**

1. Minimum length of sampling tube to be 12 inches.

### **E. High Limit Duct Sensor**

1. Insertion type, with setpoint adjustable in 2.

### **F. DIFFERENTIAL PRESSURE SENSORS**

1. Provide for each fan or pump specified as requiring this device and for each application requiring a status indication, as indicated on the point list.

Differential pressure sensing devices shall sense both inlet and outlet of fans and pumps.

**G. CURRENT SENSORS**

1. Provide for each fan or pump specified, or shown on point list as requiring this device a current sensor with adjustable threshold and digital output with LED display, equal to a Veris model H-708.

**H. BUILDING STATIC PRESSURE SENSORS**

1. One pipe, direct acting, double bell, differential type with temperature compensation, scale range 0.01 to 1.0 inch WG positive or negative, and sensitivity of 0.0005 inch wg. Transmit a DDC signal to receiver with matched scale range.

**I. PRESSURE TRANSMITTERS**

1. One pipe, direct acting, indicating type, with range suitable for system, and proportional DDC output as required.

**PART 3 - EXECUTION**

**3.01 INSTALLATION**

- A. This Contractor shall provide all labor, materials, engineering, software permits, tools, check-out and certificates required to install a complete DDC automation system as herein specified. This system shall fully communicate through all I/O devices, central processing unit (CPU), and digital communication trunks. This digital communications trunk shall be true bi-directional analog and digital communications.
- B. Any and all points on this project shall be grouped for display purposes into the system such that all points associated with the DDC system can appear together on the CRT display or printed log. Assignment of points to a group shall not be restricted by hardware configuration of the points of direct digital control. It shall be possible to assign a point to appear in more than one system. Each system shall be identified by an English descriptor and an alpha/numeric identifier.
- C. This central campus automation system as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and check-out necessary for a fully operational system.
- D. All electronic work required as an integral part of the automation system work is the responsibility of this section unless specifically indicated otherwise in this section or in Division 16.
- E. BAS vendor shall demonstrate the ability to upgrade 5 year of BAS hardware to operate with the latest release software revisions. This shall be done with "Firmware Chip" additions only. No integrators shall be allowed. A system expansion with lesser capabilities will not be accepted. This contractor shall provide evidence of having done five (5) similar installations and shall insure that the system installation will not alter the UL listing of the new system.
- F. Install system and materials in accordance with manufacturer's instructions, rough-in drawings and details on drawings.

### 3.02 ELECTRICAL

- A. All work and materials are to conform in every detail to the rules and requirements of the Wisconsin Electrical Code and present manufacturing standards. All material shall be UL approved.
- B. This Contractor shall be responsible for all line voltage and low voltage electrical wiring incidental to the system installation.
- C. All sensor and output wiring shall be shielded cable as required by the equipment manufacturer.
- D. The field wiring connections of all field-mounted sensors shall be adequately protected by a junction box mounted at the point of measurement.
- E. Separate conduit systems shall be provided for sensor wiring and high voltage (120 VAC) wiring.
- F. All low voltage exposed wiring provided by this Contractor shall be enclosed in conduit (EMT). All line voltage provided by this Contractor shall be enclosed in conduit (EMT).
- G. All conduit shall be secured at regular intervals and run parallel with the lines of the building.
- H. Power to local temperature control panels shall be provided by the BAS Contractor.
- I. DDC panels serving equipment fed by emergency power shall also be served by emergency power.
- J. All line voltage wiring required to power the DDC Controllers shall be provided by BAS contractor.
- K. BAS Identification Standards:
  - 1. Node Identification. All nodes shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the node location.
  - 2. Cable shall be labeled at a minimum of every 18" with the FMS System manufacturer's name and the type of signal carried within the cable, i.e. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC.
  - 3. Each of the cable types specified in Item A shall be of a different color coding for easy identification and troubleshooting. Recommended color coding:

a.	Analog Input Cable	Yellow
b.	Analog Output Cable	Tan
c.	Binary Input Cable	Orange
d.	Binary Output Cable	Violet
e.	24 VAC Cable	Gray
f.	General Purpose Cable	Natural
g.	Tier 1 Comm Cable	Purple
h.	Other Tier Comm Cable	Blue
- L. Raceway Identification. All the covers to junction and pull boxes of the FMS raceways shall be painted with the appropriate color.
- M. Wire Identification - all low and line voltage FMS wiring shall be identified by a number, as referenced to the associated shop drawing and as-built drawing, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.

### **3.03 CONTROL DAMPERS**

- A. All control dampers furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.
- B. Coordinate installation with the sheetmetal installer to obtain smooth duct transitions where dampers size is different than duct size. Blank off plates will not be accepted.
- C. Each operator shall serve a maximum damper area of 30 square feet. Where larger dampers are used, provide multiple operators.

### **3.04 CONTROL VALVES**

- A. All temperature control valves furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.

### **3.05 ROOM THERMOSTATS AND TEMPERATURE SENSORS**

- A. Check and verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate room thermostats 48 inches above floor. Align with light switches and humidistats.
- B. Any room thermostats mounted on an exterior wall shall be mounted on a thermally insulated sub-base.

### **3.06 LOW LIMIT THERMOSTATS (FREEZE STATS)**

- A. Install low limit controls where indicated on the drawings or as specified. Unless otherwise indicated, install sensing element on the downstream side of heating coils.
- B. Mount units using flanges and element holders. Provide duct collars or bushings where sensing capillary passes through sheetmetal housings or ductwork; seal this penetration to eliminate air leakage.
- C. Distribute (serpentine) sensing element horizontally across the coil to cover every square foot of coil; on larger coils this may require more than one instrument. Install controls at accessible location with mounting brackets and element duct collars where required.

### **3.07 AIR FLOW MEASURING STATIONS**

- A. Install airflow stations in accordance with manufacturer's recommendations. Where units are installed within 10 feet of an elbow or transition, install straightening vanes upstream of unit.

### **3.08 GRAPHICS**

- A. Provide a dynamic graphic representation for all major systems (i.e., AHU, Chilled Water System, Hot Water System, Boilers, etc.). Also provide floor plan layouts with linked temperature sensors for all digitally controlled terminal control (vav, reheat, FCU, etc.). Show building entry graphic with links to other buildings and then the system graphics.

### **3.09 COMMISSIONING**

- A. Fully commission all aspects of the Facility Management System work.
- B. Acceptance Check Sheet:
  - 1. Prepare a check sheet that includes all points for all functions of the FMS
  - 2. Submit the check sheet to the Engineer for approval one month prior to testing.
  - 3. Complete the check sheet for all items and functions of the FMS and initial each entry with time/date as record of having fully calibrated and tested the FMS. Submit to Engineer.
  - 4. The Engineer will use the check sheet as the basis for acceptance testing with the FMS Contractor.
- C. VAV box performance verification and documentation:
  - 1. The FMS Contractor shall test each VAV box for where the dampers in one half of a group of boxes are stepped towards full open while the other half are stepped towards full closed. At each step, after a settling time, box air flows and damper positions will be sampled. Following the cycle, a pass/fail report indicating results shall be produced. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.
  - 2. The FMS Contractor shall issue a report based on a sampling of the VAV calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data, and shall also include graphical representations of performance. The sampling shall take place after completion of Test and Balance, when design cooling and heating media have been available and occupied conditions approximated for five consecutive days.
  - 3. Provide all necessary specialist labor, materials and tools to demonstrate to the Engineer that the FMS has been commissioned and is operating in compliance with the contract. Prepare a list of noted deficiencies signed by both the Engineer and the FMS Contractor. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

**END OF SECTION**



**SECTION 23 09 93**  
**SEQUENCE OF OPERATION FOR HVAC CONTROLS**

**PART 1 - GENERAL**

**SCOPE**

This section includes control sequences for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Description of Work

Submittals

Operation and Maintenance Data

Design Criteria

**PART 2 - PRODUCTS**

Not Applicable

**PART 3 - EXECUTION**

General Control

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 23 09 14 - Electric Instrumentation and Control Devices for HVAC

Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination

Division 23 - HVAC - Equipment provided to be controlled or monitored

Division 26 - Electrical - Equipment provided to be controlled or monitored

Division 28 - Electronic Safety and Security

**REFERENCE**

Section 23 09 14 work includes furnishing and installing all field devices, equipment, and all related field wiring, interlocking control wiring between equipment, sensor mounting, etc., that is covered in that section.

Motorized control dampers and actuators are also covered in Section 23 09 14.

**DESCRIPTION OF WORK**

Control sequences are hereby defined as the manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.

Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.

All temperature sensing, and all other control signal transportation for the control sequences shall be furnished under Section 23 09 14.

Sequences for equipment controlled by electric self-contained controls are accomplished by hardware provided under Section 23 09 14.

**SUBMITTALS**

Refer to Division 1, General Conditions, Submittals, Section 23 05 00 and 23 09 14 for descriptions of what should be included in the submittals.

Shop drawings shall be provided by contractor(s) providing equipment under Section 23 09 14. The contractor providing the 23 09 14 equipment shall provide a complete narrative of the sequence of operation for equipment that is controlled directly from that equipment. The narrative of the sequence of operation shall not be a verbatim copy of the sequences contained herein, but shall reflect the actual operation as applied by the contractor.

## OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

## DESIGN CRITERIA

Reference Section 23 09 14.

## **PART 2 - PRODUCTS**

Not applicable to this Section – reference Section 23 09 14 for product descriptions.

## **PART 3 - EXECUTION**

### **CONTROL SEQUENCES**

#### GENERAL:

#### **SETPOINTS:**

All setpoints indicated in the control specification are to be adjustable. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process. The following setpoints should be used as initial setpoints unless otherwise specified in the individual control sequences or instructed by the Owner. If the contractor fails to check with the Owner for final setpoints, they shall adjust setpoints at no additional cost.

Occupied Space Terminal Unit Heating: 68° F  
Occupied Space Terminal Unit Cooling: 76° F  
Unoccupied Space Terminal Unit Heating: 62° F  
Unoccupied Space Terminal Unit Cooling: 82° F  
Entry Way Heating: 60° F  
Mechanical or Unoccupied Space Heating: 60° F  
Ambulance Garage: 60° F

#### **BUILDING OCCUPANCY SCHEDULE:**

Equipment required to operate during building occupancy shall be provided with hard-wired programmable timers. Timers shall be programmed by this contractor based on building schedule to be provided by owner.

Occupied and unoccupied modes for furnaces F-1 and F-2 shall coincide with building occupancy schedule.

#### **ANTI-CYCLING:**

When HVAC equipment or a sequence is specified to be started and stopped by a temperature setpoint, packaged controls shall have anti-cycling protection.

#### **DAMPER INTERLOCKS FOR FANS WITH STARTERS:**

For fan systems with magnetic starters and shutoff dampers, the damper interlock shall be hardwired in such a way that the damper shall open if the fan starter hand / off / auto switch is in the hand or in the auto position and being called to start.

#### **THERMOSTATS AND SENSORS:**

All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans. Consult the HVAC design engineer for the thermostat or sensor location when these are not shown on plans.

#### **EF-2 (TOILET EXHAUST):**

Toilet exhaust fan shall operate continuously during building occupancy.

#### **CF-1 and CF-2 (DE-STRATIFICATION FANS):**

De-stratification fans shall be controlled by a remote wall mounted speed controller (see plans for location).



1 EWH-X (ELECTRIC WALL HEATER):

2  
3 Electric wall heater shall have integral electrical circuit such that fan, electric resistance element, thermostat, etc.  
4 work in unison to satisfy specified control sequence. Integral controller shall also include all necessary safeties to  
5 prevent electric element from overheating.  
6

7 Furnish remote wall mounted line-voltage thermostat to be wired by electrician.  
8

9 Electric wall heater shall cycle to maintain space temperature of 68° F (adjustable).  
10

11 EBB-X (ELECTRIC BASEBOARD HEATER):

12  
13 Electric baseboard heater shall have integral electrical circuit such that electric resistance element, thermostat, etc.  
14 work in unison to satisfy specified control sequence. Integral controller shall also include all necessary safeties to  
15 prevent electric element from overheating.  
16

17 Furnish remote wall mounted line-voltage thermostat to be wired by electrician.  
18

19 Electric wall heater shall cycle to maintain space temperature of 68° F (adjustable).  
20

21 F-1 AND F-2 (GAS-FIRED FURNACE WITH DX COOLING):

22  
23 Furnace controllers shall be capable of commanding outdoor air dampers open/closed as well as commanding toilet  
24 exhaust on/off via programmable scheduling of occupied/unoccupied modes, via furnace controls or additional  
25 relays to be provided by this contractor in order to satisfy specified sequence of controls.  
26

27 Furnace heating system shall have integral controller such that forced draft burner, supply fan, ignition, gas valve,  
28 thermostat, etc. operate in unison to satisfy specified control sequence. Integral controller shall also include all  
29 necessary safeties, high limit control, pressure switches, fan delays, etc. as specified in 23-54-00.  
30

31 DX split system shall have integral controller such that supply fan, compressor, expansion valve, condenser fan, etc.  
32 work in unison to satisfy specified control sequence. Integral controller shall also have all necessary delays to  
33 protect unit from short-cycling as specified in equipment spec section.  
34

35 Provide remote wall mounted thermostat as specified in 23-09-14.  
36

37 ERU-X (ENERGY RECOVERY UNIT)

38  
39 Energy recovery unit shall operate to temper minimum outside air. Energy recovery unit shall not operate while  
40 associated furnace is operating in economizer mode for free cooling. During economizer mode energy recovery unit  
41 shall shut down and unit shall be by-passed. ERU-1 exhaust fan shall operate continuously during the building  
42 occupied cycle as it is providing the required general building exhaust for the toilet rooms and utility space.  
43

44 SPACE OCCUPIED MODE:

45 Supply fan shall run continuously.  
46

47 On a call for heating, furnace heating system shall engage to maintain occupied set point. When the space  
48 temperature is satisfied, furnace heating system shall be de-engaged.  
49

50 On a call for cooling, DX split system shall engage to maintain occupied set point. When the space temperature is  
51 satisfied, DX split system shall be de-engaged.  
52

53 SPACE UNOCCUPIED MODE:

54 Supply fan shall run continuously.  
55

56 On a call for heating, furnace heating system shall engage to maintain unoccupied set point. When the space  
57 temperature is satisfied, furnace heating system shall be de-engaged.  
58

59 On a call for cooling, DX split system shall engage to maintain unoccupied set point. When the space temperature is  
60 satisfied, DX split system shall be de-engaged.  
61

62 BUILDING UNOCCUPIED MODE:

1 When both F-1 and F-2 are in unoccupied mode, outdoor air dampers CD-X and CD-X shall close and ERU-1 shall  
2 be commanded off.  
3  
4  
5

END OF SECTION

**SECTION 23 11 00**  
**FACILITY FUEL PIPING**  
**PART 1 - GENERAL**

**SCOPE**

This section contains specifications for fuel pipe and fuel pipe fittings for this project. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Shop Drawings
- Quality Assurance
- Delivery, Storage, and Handling
- Design Criteria
- Welder Qualifications
- Natural Gas Service

**PART 2 - PRODUCTS**

- Natural Gas
- Vents
- Unions and Flanges

**PART 3 - EXECUTION**

- Preparation
- Erection
- Welded Pipe Joints
- Threaded Pipe Joints
- Natural Gas
- Vents
- Unions and Flanges
- Piping System Leak Tests

**RELATED WORK**

Section 23 05 23 - General-Duty Valves for HVAC Piping  
Section 23 05 15 - Piping Specialties  
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**TYPE E OR S STEEL PIPE:**

Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

**QUALITY ASSURANCE**

Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

**DELIVERY, STORAGE, AND HANDLING**

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place.

Offsite storage agreements will not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

## **DESIGN CRITERIA**

Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

Where weld fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

## **WELDER QUALIFICATIONS**

Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code and/or the National Certified Pipe Welding Bureau.

## **PART 2 - PRODUCTS**

### **NATURAL GAS**

2" and Smaller: ASTM A53, type E or S, standard weight (schedule 40) black steel pipe with ASTM A197/ANSI B16.3 class 150 black malleable iron threaded fittings or ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

### **VENTS**

Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

### **UNIONS AND FLANGES**

2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.

## **PART 3 - EXECUTION**

### **PREPARATION**

Remove all foreign material from interior and exterior of pipe and fittings.

### **ERECTION**

Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

"Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

Install all valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

### **WELDED PIPE JOINTS**

Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

## THREADED PIPE JOINTS

Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

## NATURAL GAS

Pitch horizontal piping down 1" in 60 feet in the direction of flow. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top or side of the main.

Do not install gas pipe in a ventilation air plenum.

If an above ground vent terminates in an area subject to snow accumulation, terminate the line at least five feet above grade.

Install a shut off valve and pressure regulator at each appliance. Provide a valved connection at the main for equipment and appliances furnished by others.

Each gas pressure regulating valve vent shall be run separately to a point outside of the building, terminated with a screened vent cap, and located according to gas utility regulations.

Clean all welded piping before all regulators and control valves. Test by placing target cloth over piping and blow

with compressed air. Clean piping until target cloth is clean and free of debris.

## VENTS

Install vent where required for pressure regulators. In no event is a termination to occur less than six feet above a roof line.

## UNIONS AND FLANGES

Install a union or flange, as required at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

## PIPING SYSTEM LEAK TESTS

Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.

Provide all piping, fittings, blind flanges, and equipment to perform the testing.

Conduct pressure test with test medium of air specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.

For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

Measure natural gas system test pressure with a water manometer or an equivalent device calibrated in increments not greater than 0.1 inch water column. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.

System	Pressure	Medium	Duration
Natural gas	100 psig	Air	24 hr

All pressure tests are to be documented and submitted to General Contractor.

1  
2 On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and  
3 hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final  
4 connections to piping. Die penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the  
5 active system.  
6

7  
8  
END OF SECTION

**SECTION 23 23 00  
REFRIGERANT PIPING**

**PART 1 - GENERAL**

**SCOPE**

This section contains specifications for all Refrigerant piping for this project. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Reference

Quality Assurance

Delivery, Storage, and Handling

Design Criteria

**PART 2 - PRODUCTS**

Refrigerant Piping

Refrigerant Piping Accessories

**PART 3 - EXECUTION**

Preparation

Erection

Refrigerant Piping

Refrigerant Piping Accessories

**RELATED WORK**

Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

Section 23 07 00 - HVAC Insulation

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**QUALITY ASSURANCE**

Order all copper refrigeration tube with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier; with soft straight lengths or coils identified with a tag indicating that the product was manufactured in accordance with ASTM B280; and with each hard temper straight length identified throughout its length by a blue colored marking not less than 3/16 inch in height and a legend at intervals of not greater than three feet that includes the designation "ACR" and pipe outside diameter.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

**DELIVERY, STORAGE, AND HANDLING**

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. If end caps are not present on tube bearing the "ACR" designation, clean and re-cap in accordance with ASTM B280. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

Offsite storage agreements will not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

**DESIGN CRITERIA**

Use only new material, free of defects and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

**PART 2 - PRODUCTS**

**REFRIGERANT PIPING**

ASTM B88 type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR", with ANSI B16.22 wrought copper or forged brass solder-type fittings.

Manufacturer provided pre-charged tubing is acceptable in lieu of aforementioned pipe specification.

## **PART 3 - EXECUTION**

### **PREPARATION**

Remove all foreign material from interior and exterior of pipe and fittings.

### **ERECTION**

Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment

Install all valves and piping specialties, including items furnished by others, as specified and/or detailed by manufacturer.

### **REFRIGERANT PIPING**

Refrigeration piping to be installed by firms who are experienced in installation of such piping and in accordance with the requirements of the Wisconsin Administrative Code Section ILHR 45.

All solder joints to be ASTM Grade 4 or 5 and have a melting point of approximately 1250 degrees F. Solder impurities shall not exceed 0.15%. Tubing to be new and delivered to the job site with the original mill end caps in place. Clean and polish all joints before soldering. Avoid prolonged heating and burning during soldering. Purge all lines with nitrogen during soldering. Provide manual shut-off and check valves as required.

No refrigerant is to be vented directly to the atmosphere except that which may escape through leaks in the system during leak testing. During evacuation procedures, use equipment designed to recover and allow recycling of the refrigerant.

Leak test the system by charging the system to a pressure of 10 psig with an HFC refrigerant, with the compressor suction and discharge valves closed and with all other system valves open. Increase pressure to 300 psig with dry nitrogen. Rap all joints with a mallet and check for leaks with an electric leak detector having a certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.

After completion of the leak test, evacuate the system with a vacuum pump to an absolute pressure not exceeding 1500 microns while the system ambient temperature is above 60°F. Break the vacuum to 2 psig with the refrigerant to be used in the system. Repeat the evacuation process, again breaking the vacuum with refrigerant. Install a drier of the required size in the liquid line, open the compressor suction and discharge valves, and evacuate to an absolute pressure not exceeding 500 microns. Leave the vacuum pump running for not less than two hours without interruption. Raise the system pressure to 2 psig with refrigerant and remove the vacuum pump.

Charge refrigerant directly from original drums through a combination filter-drier. Each drier may be used for a maximum of three cylinders of refrigerant and then must be replaced with a fresh drier. Charge the system by means of a charging fitting in the liquid line. Weigh the refrigerant drum before charging so that an accurate record can be kept of the weight of refrigerant put in the system. If refrigerant is added to the system through the suction side of the compressor, charge in vapor form only.

END OF SECTION



**SECTION 23 31 00**  
**HVAC DUCTS and CASINGS**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for all duct systems used on this project. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Reference

Quality Assurance

Design Criteria

**PART 2 - PRODUCTS**

General

Materials

Low Pressure Ductwork (Maximum 2 inch pressure class)

Exhaust Duct (Moisture laden air)

Duct Sealant

Gaskets

**PART 3 - EXECUTION**

Installation

Low Pressure Duct (Maximum 2 inch pressure class)

Exhaust Duct (Moisture laden air)

Cleaning

**APPENDIX**

Duct Leakage Test Report

**RELATED WORK**

Section 23 01 30.51 – HVAC Air Duct Cleaning

Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

Section 23 33 00 – Air Duct Accessories

**REFERENCE**

Applicable provisions of Division 1 govern work under this Section.

**QUALITY ASSURANCE**

Refer to Division 1, General Conditions, Equals and Substitutions.

**DESIGN CRITERIA**

Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.

Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:

- HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005
- HVAC Air Duct Leakage Test Manual, 2<sup>nd</sup> Edition, 2012
- HVAC Systems - Duct Design, 4th Edition, 2006
- Rectangular Industrial Duct Construction Standard, 2nd Edition, 2004

Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

**DELIVERY, STORAGE AND HANDLING**

Promptly inspect shipments to ensure that Ductwork is undamaged and complies with the specification.

Protect Ductwork against damage.

Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end caps/package are provided, take precautions so caps/package remain in place and free from damage.

1 Offsite storage agreements do not relieve the contractor from using proper storage techniques.

2  
3 Storage and protection methods must allow inspection to verify products.

## 4 5 6 **PART 2 - PRODUCTS**

### 7 **GENERAL**

8 All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork and  
9 spiral duct take-offs 12" and below may be 26 gauge where allowed in SMACNA HVAC Duct Construction  
10 Standards, Metal and Flexible, 3rd Edition, 2005.

11  
12  
13 Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of  
14 liner.

### 15 **DUCTWORK PRESSURE CLASS**

16 Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or  
17 negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G.  
18 positive or negative, depending on the application.

### 19 **MATERIALS**

#### 20 **GALVANIZED STEEL SHEET:**

21 Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square  
22 foot, both sides of sheet, G90 in accordance with ASTM A90.

#### 23 **LOW PRESSURE DUCTWORK (Maximum 2 inch pressure class)**

24 Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA  
25 recommendations, except as modified below.

26 Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when  
27 fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet  
28 metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw  
29 does not extend more than 1/2 inch into the duct.

30 Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a  
31 shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with  
32 SMACNA publications, Type RE 3. Where space will not allow and the C value of the radius elbow, as given in  
33 SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00.  
34 Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.

35 Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.

36 Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow  
37 velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.

38 Button punch snaplock construction will not be accepted on aluminum ductwork.

39 Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent  
40 rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission of  
41 the Architect/Engineer.

42 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of  
43 equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

#### 44 **EXHAUST DUCT (Moisture laden air)**

45 Moisture laden ductwork systems include toilet exhaust.

46 Exhaust ducts conveying moisture laden air to be constructed of galvanized sheet in accordance with SMACNA  
47 standards.

48 Seal all joints and seams watertight

## DUCT SEALANT

Manufacturer: 3M 800, 3M 900, H.B. Fuller/Foster, Hardcast, Hardcast Peal & Seal, Lockformer cold sealant, Mon-Eco Industries, United Sheet Metal, or approved equal. Silicone sealants are not allowed in any type of ductwork installation.

Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

## GASKETS

2 INCH PRESSURE CLASS AND LOWER:

Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.

# PART 3 - EXECUTION

## INSTALLATION

Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Architect in the event of any interference.

Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 4-8, Fig. E. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.

Test openings for test and balance work will be provided under Section 23 05 93.

Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.

Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.

Where two different metal ducts meet, the joint shall be installed in such a manner that metal ducts do not contact each other by using proper seal or compound.

Install all motor operated dampers and connect to or install all equipment furnished by others. Blank off all unused portions of louvers, as indicated on the drawings, with 1-1/2 inch board insulation with galvanized sheet metal backing on both sides.

Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

Provide adequate access to ductwork for cleaning purposes.

Provide temporary capping of ductwork openings to prevent entry of dirt, dust and foreign material.

Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the Ductwork.

During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

## DUCTWORK SUPPORT

Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5-5, except supporting ductwork with secure wire method is not allowed.

Support with 3/32 inch, 7 x 7, stainless steel air-craft cable, with matching serrated spring loaded wedge mechanism fasteners rated for actual load. Steel cable hanging systems will be allowed on round ductwork under 12 inches

1 diameter if installed utilizing two fasteners with two cable loops. Comply with the manufacturer's installation  
2 instructions.

3  
4 **LOW PRESSURE DUCT (Maximum 2 inch pressure class)**

5 Seal all duct, with the exception of transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints,  
6 and penetrations shall be sealed.

7  
8 Install a manual balancing damper in each branch duct and for each diffuser or grille. The use of splitter dampers,  
9 extractors, or grille face dampers will not be accepted for balancing dampers.

10  
11 Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheetmetal screws or pop  
12 rivets. Trapeze hangers may be used at contractor's option.

13  
14 **EXHAUST DUCT (Moisture laden air)**

15 Pitch duct to drain back to equipment or exhaust grille.

16  
17 Provide water tight drain pan at low points or at locations where moisture may collect. Pipe drain pan to nearest  
18 floor drain.

19  
20 **CLEANING**

21 Remove all dirt and foreign matter from the entire duct system and clean diffusers, registers, grilles and the inside of  
22 air-handling units before operating fans.

23  
24  
25  
26  
END OF SECTION

**SECTION 23 33 00**  
**AIR DUCT ACCESSORIES**

**PART 1 - GENERAL**

**SCOPE**

This sections includes accessories used in the installation of duct systems. Included are the following topics:

**PART 1 - GENERAL**

Related Work

Reference

Quality Assurance

Shop Drawings

Operation and Maintenance Data

**PART 2 - PRODUCTS**

Manual Volume Dampers

Turning Vanes

Fire Dampers

Control Dampers

Access Doors

Flexible Duct

Duct Lining

Flashings

Duct Flexible Connections

Louvers

**PART 3 - EXECUTION**

Manual Volume Dampers

Turning Vanes

Fire Dampers

Control Dampers

Access Doors

Flashings

Duct Flexible Connections

Louvers

**RELATED WORK**

Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment

Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment

Section 23 31 00 – HVAC Ducts and Casings

**REFERENCE**

Applicable provisions of Division 1 govern work under this Section.

**QUALITY ASSURANCE**

Refer to division 1, General Conditions, Equals and Substitutions

**SHOP DRAWINGS**

Refer to division 1, General Conditions, Submittals.

Submit for all accessories and include dimensions, capacities, ratings, installation instructions, and appropriate identification.

Include certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance of sound attenuators.

Submit manufacturer's color charts where finish color is specified to be selected by the Architect/Engineer.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**PART 2 - PRODUCTS**

## **MANUAL VOLUME DAMPERS**

Manufacturers: Ruskin, Vent Products, Air Balance, or approved equal.

Dampers must be constructed in accordance with SMACNA Fig. 2-12, Fig. 2-13, and notes relating to these figures, except as modified below.

Reinforce all blades to prevent vibration, flutter, or other noise. Construct dampers in multiple sections with mullions where width is over 48 inches. Use rivets or tack welds to secure individual components; sheet metal screws will not be accepted. Provide operators with locking devices and damper position indicators for each damper; use an elevated platform on insulated ducts. Provide end bearings or bushings for all volume damper rods penetrating ductwork constructed to a 3" w.c. pressure class or above.

## **TURNING VANES**

Manufacturers: Aero Dyne, Anemostat, Barber-Colman, Hart & Cooley, or approved equal.

Construct turning vanes and runners for square elbows in accordance with SMACNA Fig. 2-3 and Fig. 2-4 except use only airfoil type vanes. Construct turning vanes for short radius elbows and elbows where one dimension changes in the turn in accordance with SMACNA Fig. 2-5 and Fig. 2-6.

## **FIRE DAMPERS**

Manufacturers: Air Balance, Advanced Air, American Warming and Ventilating, Greenheck, Phillips-Aire, Prefco, Ruskin, Safe-Air or approved equal.

### **DYNAMIC FIRE DAMPERS**

Dynamic fire damper assemblies must be UL 555 (6<sup>th</sup> edition) listed and labeled for dynamic applications (where air systems operate during a fire) and meet requirements of NFPA 90A. Dampers must be type B curtain type with curtain 100% out of air stream. Dampers larger than 30" by 30" or with velocity rating requirements of 3000 fpm or higher, may be multiblade type with blades located in the airstream. Velocity ratings and static pressure ratings as indicated on the drawings. Damper fire rating to be compatible with the rating of the building assembly in which the damper is used.

## **CONTROL DAMPERS**

Control dampers are specified in section 23 09 14.

## **ACCESS DOORS**

Access doors to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be aluminum or steel full length continuous piano type. Doors in concealed spaces shall be secured in place with cam sash latches. For both hinged and non-hinged doors provide sufficient number of cam sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.

## **FLEXIBLE DUCT**

Manufacturers: Anco Products, Clevaflex, Thermaflex, Flexmaster or approved equal.

Factory fabricated, UL 181 listed as a class 1 duct, and having a flame spread of 25 or less and a smoke developed rating of 50 or under in accordance with NFPA 90A.

Suitable for pressures and temperatures involved but not less than a 180°F service temperature and ±2 inch pressure class, depending on the application.

Duct to be composed of polyester film, aluminum laminate or woven and coated fiberglass fabric bonded permanently to corrosion resistant coated steel wire helix. Two-ply, laminated, and corrugated aluminum construction may also be used.

Where duct is specified to be insulated, provide a minimum 1 inch fiberglass insulation blanket with maximum thermal conductance of 0.23 K (75 degrees F.) and vapor barrier jacket of polyethylene or metalized reinforced film laminate. Maximum perm rating of vapor barrier jacket to be 0.1 perm.

## **DUCT LINING**

Manufacturer: Manville, Owens-Corning, Knauf, or approved equal.

1 inch thick, flexible, mat faced insulation made from inorganic glass fibers bonded with a thermosetting resin with thermal conductivity of .25 Btu inch / hour sq.ft. deg F.

Meet erosion testing per UL 181 or ASTM C 1071 for 5000 fpm maximum air velocity. ASTM C 411 maximum operating temperature rating of 250 deg F. ASTM E84 flame spread less than 25 and smoke developed less than 50.

Meet requirements of ASTM C 1338 and ASTM G21 for fungi resistance.

Install liner using adhesive conforming to ASTM C 916.

## **FLASHINGS**

Provide flashing to completely weatherproof connection of ductwork to louvers. Flashing to be constructed of material similar to louver material.

## **DUCT FLEXIBLE CONNECTIONS**

Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.

Connections to be a minimum of 3 inches wide, crimped into metal edging strip, and air tight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.

Use coated glass fiber fabric for all applications. Material for inside applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with neoprene, air and water tight, suitable for temperatures between -10°F and 200°F, and have a nominal weight of 30 ounces per square yard.

## **LOUVERS**

Manufacturers: Airlite K6776, Industrial Louvers 658, American Warming and Ventilating LE-31, Construction Specialties 6177, Ruskin ELF6375DX or approved equal.

Similar to Airlite Type K6776, extruded aluminum alloy not less than 12 gauge (.081" thick), 6063 series frame and blades, all-welded assembly, 35 degree or 45 degree blades with water baffle, 6 inches thick. Provide with bird screen of ½" x ½" mesh aluminum in 12 gauge aluminum frame and an aluminum sill. Locate the bird screen inside of the louver unless noted otherwise.

Louver to bear the AMCA certified ratings seal for both air performance and water penetration, having a free area not less than 50% based on a 48" x 48" section, a water penetration less than 0.1 oz/square foot under AMCA test at 1000 feet per minute, and an intake pressure drop less than 0.20 inches of water at 1000 feet per minute.

Finish to be anodized or Kynar 500 in a custom color to be selected by the Architect. Furnish sufficient paint in the same color as the louver to paint the outer surface of panels over unused portions of louvers and to paint the interior portion of ductwork visible through the louvers.

# **PART 3 - EXECUTION**

## **MANUAL VOLUME DAMPERS**

Install manual volume dampers in each branch duct and for each grille, register, or diffuser as far away from the outlet as possible while still maintaining accessibility to the damper. Install so there is no flutter or vibration of the damper blade(s).

## **TURNING VANES**

Install turning vanes in all rectangular, mitered elbows in accordance with SMACNA standards and/or manufacturer's recommendations.

Install double wall, airfoil, 2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity less than 2000 fpm. Install double wall, airfoil, 4-1/2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity 2000 fpm or greater.

If duct size changes in a mitered elbow, use single wall type vanes with a trailing edge extension. If duct size changes in a radius elbow or if short radius elbows must be used, install sheetmetal turning vanes in accordance with SMACNA Figure 2-5 and Figure 2-6.

## **FIRE DAMPERS**

Install dampers in strict accordance with manufacturer's installation instructions. Install damper sleeves with retaining angles on both sides of rated partition. Connections of ductwork to fire damper assemblies to be as specified on the installation instructions. Where it is necessary to set dampers out from the rated wall, install a sleeve extension encased in two hour rated fire proofing insulation. Install an access door at each fire damper, located to permit resetting the damper replacing the fusible link.

Manually test each fire damper for proper operation by removing the fusible link. Repair or replace any fire damper that does not close completely. Re-install fusible link after test.

## **CONTROL DAMPERS**

Install dampers in locations indicated on the drawings, as detailed, and according to the manufacturer's instructions. Install blank-off plates or transitions where required for proper mixing of airstreams in mixing plenums. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

## **ACCESS DOORS**

Install access doors where specified, indicated on the drawings, and in locations where maintenance, service, cleaning or inspection is required. Examples include, but are not limited to motorized dampers, fire dampers, fan bearings, heating and cooling coils, filters, valves, and control devices needing periodic maintenance.

Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated.

Label fire dampers on the exterior surface of ductwork directly adjacent to access doors using a minimum of 0.5 inch height lettering reading, "FIRE DAMPER". Utilize stencils or manufactured labels. All other forms of identification are unacceptable. All labels shall be clearly visible from the ceiling access point.

## **FLEXIBLE DUCT**

Flexible duct may only be used for final connections of air inlets and outlets at diffuser, register, and grille locations. Where flexible duct is used, it shall be the minimum length required to make the final connections, but no greater than 5 feet in length, and have no more than one (1) 90 degree bend.

Secure inner jacket of flexible duct in place with stainless steel metal band clamp. Secure insulation vapor barrier jacket in place with steel or nylon draw band. Sheetmetal screws and/or duct tape will not be accepted.

Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.

Flexible ductwork used as transfer duct shall be sized for a maximum velocity of 300 fpm.

Penetration of any partition, wall, or floor with flexible duct will not be accepted.

## **DUCT LINING**

Apply lining to transfer ducts as shown on plans.

Install liner in compliance with the latest edition of NAIMA's Fibrous Glass Duct Liner Standard. Locate longitudinal joints at the corners of duct only. Cut and fit to assure lapped, compressed joints. Coat all transverse and longitudinal joints and edges with adhesive. Provide metal nosing on leading edge where lined duct is preceded by unlined duct. Adhere liner to duct with full coverage area of adhesive. Additionally secure liner to duct using mechanical fasteners spaced as recommended by the liner manufacturer without compressing liner more than 1/8" with the fasteners.

## **DUCT FLEXIBLE CONNECTIONS**

Install at all duct connections to rotating or vibrating equipment, including air handling units (unless unit is internally isolated), fans, or other motorized equipment in accordance with SMACNA Figure 2-19. Install thrust restraints to prevent excess strain on duct flexible connections at fan inlets and outlets; see Related Work.

## **LOUVERS**

Provide bird screen on inside of active louver area where none is provided with louvers.

Install insulated metal panel on unused portion of louver. Panels must be sealed weathertight to louver assembly with flashing as required for proper drainage to outside of building. Paint outside surface of panel to match louver



1 prior to installation. Where ductwork is visible through louver when viewed from outside the building, paint inside  
2 of duct to match louver color.  
3  
4  
5  
6  
7

END OF SECTION



**SECTION 23 34 00**  
**HVAC FANS**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for fans that are not an integral part of a manufactured device. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

**PART 2 - PRODUCTS**

- General
- In-line Centrifugal Fans
- Ceiling Destratification Fans

**PART 3 - EXECUTION**

- Installation
- Owner Training

**RELATED WORK**

Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment  
Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment

**REFERENCE**

Applicable provisions of Division 1 govern work under this Section.

**QUALITY ASSURANCE**

Refer to division 1, General Conditions, Equals and Substitutions.

**SHOP DRAWINGS**

Refer to division 1, General Conditions, Submittals.

Include dimensions, capacities, fan curves, materials of construction, ratings, weights, motors and drives, sound power levels, appropriate identification and vibration isolation for all equipment. Sound power levels to be based on tests performed in accordance with AMCA Standard 300.

Fan curves shall indicate the relationship of CFM to static or total pressure for various fan speeds. Brake horsepower, recommended selection range, and limits of operation are to also be indicated on the curves. Indicate operating point on the fan curves at design air quantity and indicate the manufacturer's recommended drive loss factor for the specific application. Tabular fan performance data is not acceptable.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**DESIGN CRITERIA**

Tested and certify all fans in accordance with the applicable AMCA test code.

Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.

Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.

Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, provide any motor, drive and/or wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.

1 All internal insulation and other components exposed to the airstream are to meet the flame spread and smoke  
2 ratings contained in NFPA 90A.  
3

## 4 5 **PART 2 - PRODUCTS**

### 6 **GENERAL**

7 Use fan size, class, type, arrangement, and capacity as scheduled.  
8

9 Furnish complete with motors, wheels, drive assemblies, bearings, vibration isolation devices, and accessories  
10 required for specified performance and proper operation. All single phase motors to have inherent thermal overload  
11 protection.  
12

13 Statically and dynamically balance all fans so they operate without objectionable noise or vibration.  
14

### 15 **IN-LINE CENTRIFUGAL FANS**

16 Manufacturers: Acme, PennBarry, Cook, Greenheck, New York Blower, Peerless, Penn, S&P, Twin City, or  
17 approved equal.  
18

19 Construct housing of welded steel with reinforcing to prevent distortion. Furnish with streamlined inlet cones and  
20 multiple straightening vanes following the fan wheel to minimize noise and reduce turbulence. Provide each  
21 housing with a bolted and gasketed access door for inspection of drive and fan wheel. Use non-overloading airfoil  
22 blade fans welded to the wheel cones. Bearings to be grease lubricated, self-aligning ball bearing type with grease  
23 seal and external grease fitting. Paint fans with a prime coat after metal cleaning and surface preparation. Apply a  
24 second coat of paint to all exterior surfaces.  
25

### 26 **DESTRATIFICATION FANS**

27 Emerson-Chromalox, Envirofan, Hunter, or approved equal.  
28

29 U.L. listed, all metal construction, baked enamel finish with factory standard color selected by Architect. Motors to  
30 be totally enclosed, impedance protected, single speed, of split capacitor design with permanently lubricated ball  
31 bearings.  
32

33 Provide solid state variable speed controls as scheduled.  
34  
35

## 36 **PART 3 - EXECUTION**

### 37 **INSTALLATION**

38 Install as shown on the drawings, as detailed, and according to manufacturer's installation instructions.  
39  
40

41 Contractor shall balance blade assembly of destratification fans after installation to assure stable operation.  
42  
43  
44

45 **END OF SECTION**  
46

## SECTION 23 37 13 DIFFUSERS, REGISTERS & GRILLES

**SECTION 23 37 13**

## DIFFUSERS, REGISTERS & GRILLES

## PART 1 - GENERAL

## PART 1 - GENERAL

## SCOPE

This section includes specifications for air terminal equipment. Included are the following topics:

## PART 1 - GENERAL

## Scope

## Related Work

## Reference

## Quality Assurance

## Submittals

## Design Criteria

## PART 2 - PRODUCTS

## Manufacturers

## Square Ceiling Diffusers

### Side-Wall Registers and Grilles

## Eggcrate Grille

## PART 3 - EXECUTION

## Installation

## RELATED WORK

Section 23 31 00 - HVAC Ducts and Casings

Section 23 33 00 - Air Duct Accessories

Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

## REFERENCE

Applicable provisions of Division 1 govern work under this section.

## QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

## SUBMITTALS

Refer to Division 1, General Conditions, Submittals.

Furnish submittal information including, but not limited to, the following:

Manufacturer's name and model number

### Identification as referenced in the documents

### Capacities/ratings

### Materials of construction

### Sound ratings

## Dimensions

## Finish

Color selection charts where applicable

Manufacturer's installation instructions

All other appropriate data

## DESIGN CRITERIA

All performance data shall be based on tests conducted in accordance with Air Diffusion Council (ADC) Test Code 1062 GRD 84.

## PART 2 - PRODUCTS

## **MANUFACTURERS**

Manufacturers: Nailor, Carnes, Krueger, Titus, Metal-Aire, and E.H. Price, and United Sheet Metal.

## **SQUARE CEILING GRILLE**

High performance type diffuser incorporating short throws and low NC levels.

Diffusers to be aluminum (Steel) unless otherwise indicated, louvered face furnished with frame type appropriate to installation.

Diffuser shall have throw characteristics of a round diffuser having a 360° horizontal blow pattern.

Louver cones shall be one-piece construction with no corner joints.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

## **SIDE-WALL REGISTERS AND GRILLES**

Material as scheduled.

Double deflection type blade supply registers and supply grilles allow deflection adjustment in all direction.

Opposed blade volume control damper supply registers, operable from face.

Fixed blade 30 degree core return and exhaust registers and grilles.

Opposed blade volume control damper return registers, operable from face.

Register and grille sizes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

Screw holes on surface counter sunk to accept recessed type screws.

## **EGGCRATE GRILLE**

Aluminum construction with frame type appropriate to installation.

Grille face 1/2" x 1/2" or 1" x 1" grid pattern 1" deep with a minimum of 85% free area.

Grille sizes and finishes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated..

Screw holes on surface counter sunk to accept recessed type screws.

## **PART 3 - EXECUTION**

### **INSTALLATION**

Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.

Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar size.

Seal connections between ductwork drops and diffusers/grilles airtight.

1 Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat  
2 black paint to reduce visibility.

3  
4 Provide surface mounted frame where air devices are installed in hard gypsum ceilings.

5  
6 Provide volume dampers at all air devices where integral volume dampers are have not been identified in GRD  
7 schedule.

8  
9  
10  
END OF SECTION





**SECTION 23 51 00  
BREECHINGS, CHIMNEYS, AND STACKS**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for B-Vent for gas-fired unit heater and CPVC vent for gas furnaces. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Reference

Quality Assurance

Shop Drawings

Design Criteria

**PART 2 - PRODUCTS**

Vents for Condensing Appliances

Double Wall Type "B" Vents and Breeching

**PART 3 - EXECUTION**

Installation

Cleaning and Protection

**RELATED WORK**

Section 23 07 00 - HVAC Insulation

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**QUALITY ASSURANCE**

Refer to Division 1, General Conditions, Equals and Substitutions

**SHOP DRAWINGS**

Refer to Division 1, General Conditions, Submittals.

Include materials of construction, dimensions, weight, support and layout of breechings. Where factory built units are used, submit layout drawings indicating plan view and elevations. Identify all methods of support and building structural members utilized for such support.

Submit manufacturer's installation instructions including required clearance to combustible materials.

**DESIGN CRITERIA**

Follow the requirements of NFPA 211 and State codes.

Factory built vents used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labelled.

**PART 2 - PRODUCTS**

**VENTS FOR CONDENSING APPLIANCES**

Provide vents, fittings, and accessories constructed of schedule 40 CPVC where in accordance with appliance manufacturer's recommendations.

Size vents in strict accordance with appliance manufacturer's requirements.

**DOUBLE WALL TYPE "B" GAS VENTS AND BREECHING**

Manufacturer: Selkirk Metalbestos, Metal-Fab, Air-Jet, Hart & Cooley, General Products Co., or approved equal.

Vent pipe, breeching, and accessory fittings to be UL listed type "B".

Fabricate inner pipe of sheet aluminum or stainless steel, and outer pipe of galvanized sheet steel, tested in compliance with UL 441. Minimum thickness of inner and outer pipes to be as follows:

Pipe Size	Thickness Inner Pipe	Thickness Outer Pipe
Round, up to 6"	0.012"	28 gage
Round, 7" to 18"	0.014"	28 gage

Provide all necessary accessories including flashing, counter flashing, storm collar, insulated thimble, rain cap with bird screen, clean out, fittings and all necessary supports.

### **PART 3 - EXECUTION**

#### **INSTALLATION**

##### **CONDENSING APPLIANCE VENTS:**

Pitch exhaust vents up from appliance to point of termination outside building. Provide low point dirt leg at exterior wall termination and equipment when recommended by manufacturer.

Locate exhaust termination and combustion air intake in accordance with appliance manufacturer's recommendations to prevent re-entry of products of combustion.

Termination of exhaust within 3 feet of operable windows, other building openings will not be accepted. Termination of exhaust to be no less than 2' above intakes located within 10'.

Pitch combustion air vents from intake down toward appliance connection.

All joints of combustion air and exhaust vents shall be solvent welded and leak tight. Provide drain connection at base of exhaust vent, and pipe to nearest open site drain.

#### **CLEANING AND PROTECTION**

Clean vents internally during installation to remove dust and debris. Clean external surfaces to remove welding slag and mill film.

At ends of vents which are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until final connections are made.

**END OF SECTION**

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**SECTION 23 54 00**  
**GAS FIRED FURNACES**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for gas fired furnaces. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Quality Assurance
- Energy Efficiency
- Submittals
- Operation and Maintenance Data
- Warranty

**PART 2 - PRODUCTS**

Furnaces

**PART 3 - EXECUTION**

- Installation
- Furnaces
- Owner Training

**RELATED WORK**

Section 23 11 00 - Facility Fuel Piping  
Section 23 51 00 - Breechings, Chimneys, and Stacks

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**QUALITY ASSURANCE**

Refer to Division 1, General Conditions, Equals and Substitutions.

**ENERGY EFFICIENCY**

Provide gas furnaces that bear the ENERGY STAR label and meet the ENERGY STAR specifications for energy efficiency.

**SUBMITTALS**

Refer to Division 1, General Conditions, Submittals.

Include specific manufacturer and model numbers, equipment identification corresponding to project drawings and schedules, dimensions, capacities, materials of construction, ratings, weights, power requirements and wiring diagrams, filter information and information for all accessories.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**WARRANTY**

Furnace primary and secondary heat exchangers warranted for 20 years under normal use and maintenance.  
Remainder of furnace components warranted for 1 year from date of start up.

**PART 2 - PRODUCTS**

**FURNACES**

Manufacturers: Bryant, Carrier, Lennox, Trane or York, Reznor.

Direct vent, sealed combustion, condensing type AGA certified for use with natural gas. Minimum annual fuel utilization efficiency (A.F.U.E.) of 80. All ratings are to be certified by GAMA. All wiring shall comply with the National Electrical Code.

22 gauge steel casing with baked enamel finish or prepainted galvanized steel. Insulate casing back and side panels with foil faced fiberglass insulation.

Construct primary heat exchanger of aluminized steel. Construct secondary heat exchanger of stainless steel with aluminum fins or of polypropylene laminated steel. Aluminized steel multi-port in-shot burner with hot surface or electronic spark ignition, approved for vertical or sidewall venting.

AGA listed gas controls including manual main shut-off valve, double automatic gas valves for redundancy and gas pressure regulator.

Centrifugal type blower fan statically and dynamically balanced with multiple speed, direct drive or belt drive fan motor. Provide low energy induced draft blower for heat exchanger prepurge and combustion gas venting.

Provide unit with 2" thick 30% efficient disposable type panel air filter and filter holding rack with a maximum filter face velocity of 450 fpm.

Provide solid state integral control unit with all necessary controls and relays including but not limited to:

- Pressure switch for airflow of flue products through furnace and out vent system

- Rollout switch with manual reset to prevent over temperature in burner area

- Electronic flame sensor

- Blower access safety interlock

- Timed blower start after main burners ignite

- Factory installed 24 v transformer for controls and thermostat

- LED's to indicate status and to aid in troubleshooting

Provide unit with matching cased "A" configuration cooling coil.

Minimum 1/2" OD seamless copper tubing mechanically bonded to heavy ripple edged aluminum fins with thermal expansion valve, holding charge and copper tube stubs for field piping.

Non-corrosive stainless steel or polymer drain pan with 3/4" NPT drain connection.

20 gauge steel Coil casing with baked enamel finish and fiberglass insulation.

Refer to Sections 23 09 14 for temperature control work.

This Contractor shall provide all temperature control and interlocking necessary to perform the specified control sequence. All wiring is to be in conduit in accordance with Division 26 00 00 - Electrical. All relays, transformers and controls are to be in enclosures.

Provide a 7 day programmable thermostat with 2 occupied periods per day, automatic changeover, separate heating and cooling set points for both occupied and unoccupied modes. Provide auxiliary controls on sub-base to open minimum outside air damper during occupied mode. Equal to Honeywell model T7300 with Q7300 sub-base.

During occupied mode run the supply fan continuously, open the outside air damper and cycle the cooling or heating as required to maintain occupied space temperature cooling or heating set point. During unoccupied mode cycle the supply fan and cooling or heating as required to maintain unoccupied cooling or heating space temperature set point.

### **PART 3 - EXECUTION**

#### **INSTALLATION**

Install units as shown on plans, as detailed and according to the manufacturer's installation instructions.

Pipe vents from gas regulator to outside (where regulators without vent limiters are provided).

Install remote panels and thermostats where indicated on the drawings. Provide all wiring between remote panels/thermostats and the gas fired item.

1  
2 FURNACES

3 Install on concrete housekeeping pad as indicated on the drawings. Pipe condensate to hub drain.  
4

5 Provide schedule 40 PVC, ASTM D1785 combustion air and vent piping and fittings with solvent welded joints as  
6 indicated on the drawings. Terminate as recommended by the furnace manufacturer.  
7  
8

9 OWNER TRAINING

10 Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations,  
11 maintenance and troubleshooting of the system and/or components defined within this section.  
12  
13

14 END OF SECTION  
15



**SECTION 23 62 13**  
**PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSING UNITS**

**PART 1 - GENERAL**

**SCOPE**

This section includes specifications for air cooled condensing units for use with split system type air conditioning. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Delivery, Storage and Handling
- Warranty

**PART 2 – PRODUCTS**

- Units up to 5 Tons
- Refrigerant Piping Specialties

**PART 3 - EXECUTION**

- Installation
- Startup
- Owner Training

**RELATED WORK**

Section 23 05 00 - Common Work Results for HVAC

Section 23 11 00 - Facility Fuel Piping

**REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

**QUALITY ASSURANCE**

Refer to Division 1, General Conditions, Equals and Substitutions.

Unit Energy Efficiency Ratio (EER), Coefficient of Performance (COP) and Integrated Part Load Value (IPLV) shall meet the minimum applicable requirements of ASHRAE 90.1(2004 edition). Units that are labeled ENERGY STAR® will be acceptable.

Rate unit performance in accordance with the latest edition of ARI Standard 365 or ARI Standard 210/240, whichever is applicable for the equipment.

Construct units in accordance with ASHRAE 15, UL standards and the NEC. Units shall carry the UL label.

Factory run test units to see that each control device operates properly. Pressure test, evacuate, charge with holding charge of refrigerant and full oil charge prior to shipping from the factory.

**SUBMITTALS**

Refer to Division 1, General Conditions, Submittals

Submit air cooled condensing unit shop drawings including the following information: specific manufacturer and model numbers, dimensional and weight data, required clearances, materials of construction, capacities and ratings, refrigerant type and charge, component information, size and location of piping connections, electrical connections, wiring diagrams and information for all specialties and accessories.

1 Submit manufacturer's installation and start-up instructions, maintenance data, troubleshooting guide, parts lists,  
2 controls and accessories.

3  
4 At substantial completion, submit warranty certificate and copy of start-up report.

#### 5 6 OPERATION AND MAINTENANCE DATA

7 All operations and maintenance data shall comply with the submission and content requirements specified under  
8 section GENERAL REQUIREMENTS.

#### 9 10 **DELIVERY, STORAGE AND HANDLING**

11 Comply with manufacturer's instructions for storing, rigging, unloading, and transporting units. Protect units from  
12 physical damage. Leave factory-shipping covers in place until installation.

13  
14 Ship units to jobsite fully assembled

#### 15 16 **WARRANTY**

17 Provide a one year parts and labor warranty on the entire unit beginning upon substantial completion of project.

18  
19 Provide a five year parts warranty on the compressor(s) beginning upon substantial completion of project.

## 20 21 22 **PART 2 – PRODUCTS**

### 23 24 **UNITS UP TO 5 TONS**

25 Manufacturers: Carrier, Trane, York, McQuay or approved equal.

26  
27 Provide factory assembled, outdoor mounted, air-cooled condensing unit suitable for on grade installation. Include  
28 compressor, air cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating  
29 controls, motor starting components and additional features as specified herein or required for safe, automatic  
30 operation. Refrigerant is to be R-410A

### 31 32 **CABINET**

33 Construct cabinet of heavy gauge, galvanized steel coated with weather resistant paint. Provide removable access  
34 panels to facilitate full access to the compressor, fan and control components.

### 35 36 **COMPRESSOR**

37 Provide hermetic reciprocating or scroll type compressor with built in motor winding temperature and current  
38 protection, liquid and suction service valves, gage ports, sight glass and liquid line filter dryer. Provide crankcase  
39 heater with reciprocating type compressors. Mount compressors on vibration isolators.

### 40 41 **CONDENSER**

42 Provide condenser coils with aluminum alloy plate fins mechanically fastened to seamless copper tubing with  
43 integral subcooler. Construct coils with design working pressure suitable for the refrigerant.

44  
45 Provide direct-drive statically and dynamically balanced propeller type fans with vertical or horizontal discharge as  
46 indicated on the drawings and guards constructed of heavy gage PVC coated wire or galvanized steel.

### 47 48 **POWER WIRING**

49 Provide factory installed 24-volt control circuit with fusing; control power transformer and all associated internal  
50 wiring. Provide a single point power connection to the unit(s). Provide factory installed magnetic contactors for  
51 compressor and condenser motors.

52 Electrical characteristics shall be as indicated in the equipment schedule.

### 53 54 **CONTROLS**

55 Provide high/low refrigerant pressure cutouts with manual reset and anti-short cycle compressor timer.



## REFRIGERANT PIPING SIZING

The unit manufacturer shall verify the final refrigeration pipe sizing process to insure conformance to specific unit requirements such as max lengths, refrigerant velocities, unloading considerations and proper oil return. This contractor shall provide refrigeration piping drawings from the field which details the way the piping will actually be installed.

## REFRIGERANT PIPING ACCESSORIES

Provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 450 psig and a maximum working temperature of 225 deg F. For systems using R-410A, provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 850 psig and a maximum working temperature of 225 deg F.

Flexible pipe connectors: Double braided bronze hose flexible pipe connectors with solder end connections.

Sight glasses: Two piece brass construction with solder end connections. Include color indicator for sensing moisture.

Solenoid Valves: Two way normally closed with two piece brass body, full port, stainless steel plug, stainless steel spring, teflon diaphragm and solder end connections. Provide replaceable coil assembly. Provide where required by manufacturer instructions.

Thermostatic Expansion Valves: Brass body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

Charging Valves: Provide 1/4" SAE brass male flare access ports with finger tight, quick seal caps. Provide 2-inch long copper extension sections.

Check valves: Spring loaded type with bronze body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections. Provide where required by manufacturer instructions.

## PART 3 - EXECUTION

### INSTALLATION

Install units, piping and accessories in accordance with the manufacturer's written instructions and recommendations. Mount unit(s) on apoured concrete pad on grade as indicated on the drawings.

Maintain adequate service access and airflow clearances for all components as recommended by the manufacturer and as indicated on the drawings.

Charge unit(s) with full oil charge and refrigerant charge based on the entire refrigeration system pipe size and length.

Provide all control wiring in conduit in compliance with Section 23 0914 and Division 26 00 00 - Electrical.

Coordinate power wiring requirements with the electrical trade.

### STARTUP

Adjust units for maximum operating efficiency, adjust all controls to required final settings and demonstrate that all components are functioning properly. Submit four copies of a written startup report following the initial start up. Include in the report: work done to the system, all readings taken, a statement certifying that the refrigeration system(s) are leak free and a statement certifying that the unit(s) have been placed in proper running condition as recommended by the manufacturer and as intended in the drawings and specifications.

### OWNER TRAINING

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section.

END OF SECTION



DIVISION 26 – ELECTRICAL

**SECTION 26 05 00**  
**COMMON WORK RESULTS FOR ELECTRICAL**  
*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/14*

**PART 1 - GENERAL**

The electrical work included in all other divisions is the responsibility of the contractor performing the division 26 work unless noted otherwise.

**PROJECT OVERVIEW**

This project consists of a new electrical service and distribution for a DNR Public Entrance Visitor Station with lighting systems and controls, receptacles and wiring devices, motor connections and related electrical work. The project also requires telecommunication cabling, terminations and testing work under Division 27.

**SCOPE**

The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

**PART 1 - GENERAL**

- Project Overview
- Scope
- Related Work
- Reference Standards
- Regulatory Requirements
- Quality Assurance
- Continuity of Existing Services and Systems
- Protection of Finished Surfaces
- Approved Electrical Testing Laboratories
- Sleeves and Openings
- Sealing and Fire Stopping
- State and/or User Agency Furnished Equipment
- Work by State and/or User Agency
- Provisions for Future Work
- Intent
- Omissions
- Submittals
- Project/Site Conditions
- Work Sequence and Scheduling
- Work by Other Trades
- Offsite Storage
- Salvage Materials
- Certificates and Inspections
- Operating and Maintenance Data
- Record Drawings

**PART 2 - PRODUCTS**

- Access Panels and Doors
- Identification
- Sealing and Fire Stopping

**PART 3 - EXECUTION**

- Cutting and Patching
- Building Access
- Equipment Access
- Coordination

Sleeves  
Sealing and Fire Stopping  
Housekeeping and Clean Up  
Agency Training

## **RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process  
Section 07 84 00 – Fire Stopping

## **REFERENCE STANDARDS**

Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI American National Standards Institute  
ASTM American Society for Testing and Materials  
EPA Environmental Protection Agency  
ETL Electrical Testing Laboratories, Inc.  
IEEE Institute of Electrical and Electronics Engineers  
IES Illuminating Engineering Society  
ISA Instrument Society of America  
NBS National Bureau of Standards  
NEC National Electric Code  
NEMA National Electrical Manufacturers Association  
NESC National Electrical Safety Code  
NFPA National Fire Protection Association  
UL Underwriters Laboratories Inc.  
DSPS Wisconsin Department of Safety and Professional Services

## **REGULATORY REQUIREMENTS**

All work and materials are to conform in every detail to applicable rules and requirements of the Wisconsin State Electrical Code (SPS 316), the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

All Division 26 work shall be done under the direction of a currently licensed State of Wisconsin Master Electrician.

## **QUALITY ASSURANCE**

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space, and for obtaining the performance from the system into which these items are placed.

Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by DFD, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, except for medium voltage equipment and components, shall be so labeled.

## **CONTINUITY OF EXISTING SERVICES AND SYSTEMS**

Temporary electrical services will be required at the site.

1  
2 **PROTECTION OF FINISHED SURFACES**

3 Furnish one can of touch-up paint for each different color factory finish furnished by the  
4 Contractor. Deliver touch-up paint with other "loose and detachable parts" as covered in the  
5 General Requirements.

6  
7 **APPROVED ELECTRICAL TESTING LABORATORIES**

8 The following laboratories are approved for providing electrical product safety testing and listing  
9 services as required in these specifications:

10  
11 Underwriters Laboratories Inc.  
12 Electrical Testing Laboratories, Inc.  
13

14 **SLEEVES AND OPENINGS**

15 Refer to Division 1, General Requirements, Sleeves and Openings.

16  
17 **SEALING AND FIRE STOPPING**

18 Sealing and fire stopping of sleeves/openings between conduits, cable trays, wireways, troughs,  
19 cablebus, busduct, etc. and the structural or partition opening shall be the responsibility of the  
20 contractor whose work penetrates the opening. The contractor responsible shall hire individuals  
21 skilled in such work to do the sealing and fire stopping. These individuals hired shall normally  
22 and routinely be employed in the sealing and fireproofing occupation.

23  
24 **STATE AND/OR USER AGENCY FURNISHED EQUIPMENT**

25 None Anticipated  
26

27 **WORK BY STATE AND/OR USER AGENCY**

28 Network communications and security equipment will be provided and installed by the  
29 Owner's vendor.

30  
31 Electrical testing not described in these contract documents will be by the DFD under separate  
32 contract.

33  
34 **PROVISIONS FOR FUTURE WORK**

35 None anticipated beyond work shown on Contract Drawings.  
36

37 **INTENT**

38 The Contractor shall furnish and install all the necessary materials, apparatus, and devices to  
39 complete the electrical equipment and systems installation herein specified, except such parts as  
40 are specifically exempted herein.

41  
42 If an item is either called for in the specifications or shown on the plans, it shall be considered  
43 sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications  
44 or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship,  
45 which is the highest quality, largest, or most closely fits the DFD's intent (as determined by the  
46 DFD Project Manager). Refer to the General Conditions of the Contract for further clarification.

47  
48 It must be understood that the details and drawings are diagrammatic. The Contractor shall verify  
49 all dimensions at the site and be responsible for their accuracy.

50  
51 All sizes as given are minimum except as noted.

52  
53 Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike,  
54 and shall be subject at all times to the DFD's and/or A/E's inspections, tests and approval from  
55 the commencement until the acceptance of the completed work.

56  
57 Whenever a particular manufacturer's product is named, it is intended to establish a level of  
58 quality and performance requirements unless more explicit restrictions are stated to apply.

## **OMISSIONS**

No later than ten (10) days before bid opening, the Contractor shall call the attention of the DFD to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

## **SUBMITTALS**

Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.

On request from the DFD, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.

Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.

The submittals must be approved before fabrication is authorized.

Submit sufficient quantities of submittals to allow the following distribution:

Operating and Maintenance Manuals	2 copies
User agency	1 copy
A/E	1 copy
DFD Field Office	1 copy

All electronic submittals must be provided with proper specification sections and product mark-ups shall not be in 'red' - this is reserved for the A/E mark-up. All electronic submittal file shall be labeled accordingly to match transmittal. Extraneous electronic submittal information not pertaining to the project materials will result in rejection of the submittal.

## **PROJECT/SITE CONDITIONS**

Install Work in locations shown on drawings, unless prevented by project conditions.

Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of DFD before proceeding.

Tools, materials and equipment shall be confined to areas designated by the DFD and user agency.

## **WORK SEQUENCE AND SCHEDULING**

Install work in phases to accommodate user agency's occupancy requirements. During the construction period coordinate electrical schedule and operations with DFD's Construction Representative.

## **WORK BY OTHER TRADES**

Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.

Electrical details on drawings for equipment to be provided by others are based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others.

#### **OFFSITE STORAGE**

Prior approval by DFD and the A/E will be needed. The contractor shall submit Storage Agreement Form DOA-4528 to DFD for consideration of off-site materials storage. In general, building wire, conduit, fittings and similar rough-in material will not be accepted for off-site storage. No material will be accepted for off-site storage unless shop drawings for the material have been approved.

#### **SALVAGE MATERIALS**

No materials removed from this project shall be reused [except as specifically noted below]. All materials removed shall become the property of and shall be disposed of by the Contractor.

#### **CERTIFICATES AND INSPECTIONS**

Obtain and pay for all required State installation inspections, except those provided by the DFD, in accordance with the Wisconsin Administrative Code. Deliver originals of these certificates to the DFD's Project Representative.

This contractor is responsible for coordination of DFD electrical inspection. Inspection requirements will be issued at a pre-installation meeting, arranged by this contractor and the DFD Electrical Inspector (See Article 15 of the General Conditions).

#### **OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. Manufacturer's wiring diagrams for electrically powered equipment.

#### **RECORD DRAWINGS**

The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.

The DFD will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. Dimensions and elevations on the record drawings shall locate all buried or concealed piping, conduit, or similar items.

The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.

At completion of the project, the Contractor shall submit the marked-up record drawings to the Architect/Engineer prior to final payment.

### **PART 2 - PRODUCTS**

#### **ACCESS PANELS AND DOORS**

Lay-in Ceilings:

Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration provided under other divisions are sufficient; no additional access provisions are required unless specifically indicated.

Plaster Walls and Ceilings:

16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers and similar wet areas, concealed hinges, screwdriver operated cam latch for general application, key lock for use in public areas, UL listed

for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

## **IDENTIFICATION**

See Electrical section 26 05 53 – Identification for Electrical Systems.

## **SEALING AND FIRE STOPPING**

### **FIRE AND/OR SMOKE RATED PENETRATIONS:**

Manufacturers:

3M, STI/SpecSeal, Tremco, Hilti or approved equal.

All fire stopping systems shall be by the same manufacturer.

Submittals:

Contractor shall submit product data for each fire stop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.

Product:

Fire stop systems shall be UL listed or tested by an independent testing laboratory approved by the Department of Safety and Professional Services.

Use a product that has a rating not less than the rating of the wall or floor being penetrated.

Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

Contractor shall use fire stop putty, caulk sealant, intumescent wrap strips, intumescent fire stop collars, fire stop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

### **NON-RATED PENETRATIONS:**

Conduit and Cable Tray Penetrations:

At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

## **PART 3 - EXECUTION**

### **CUTTING AND PATCHING**

Refer to Division 1, General Requirements, Cutting and Patching.

### **BUILDING ACCESS**

Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

### **EQUIPMENT ACCESS**

Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties.

Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access doors.

### **COORDINATION**



1 The Contractor shall cooperate with other trades and DFD in locating work in a proper manner.  
2 Should it be necessary to raise or lower or move longitudinally any part of the electrical work to  
3 better fit the general installation, such work shall be done at no extra cost to the DFD, provided  
4 such decision is reached prior to actual installation. The Contractor shall check location of  
5 electrical outlets with respect to other installations before installing.

6  
7 The Contractor shall verify that all devices are compatible for the surfaces on which they will be  
8 used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or  
9 semi-recessed heating units installed in/on architectural surfaces.

10  
11 Coordinate all work with other contractors prior to installation. Any installed work that is not  
12 coordinated and that interferes with other contractor's work shall be removed or relocated at the  
13 installing contractor's expense.

14  
15 Cooperate with the testing consultant in ensuring specification Section 26 05 04 compliance.  
16 Verify system completion to the testing consultant. Demonstrate the starting, interlocking and  
17 control features of each system so the testing contractor can perform their work.

## 18 19 **SLEEVES**

20 Pipe sleeves for conduits 6" in diameter and smaller, in new poured concrete construction, shall  
21 be schedule 40 steel pipe, plastic removable sleeve or sheet metal sleeve, all cast in place.

22  
23 In wet area floor penetrations, the top of the sleeve shall be 2 inches above the adjacent floor. In  
24 existing wet area floor areas, core drill sleeve openings large enough to insert a schedule 40  
25 sleeve and grout the area around the sleeve. If a pipe clamp resting on the sleeve supports the  
26 pipe penetrating the sleeve, weld a collar or struts to the sleeve that will transfer weight to the  
27 existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling  
28 unit coils, converters, pumps, chillers, boilers, and similar waterside equipment.

## 29 30 **SEALING AND FIRE STOPPING**

### 31 **FIRE AND/OR SMOKE RATED PENETRATIONS:**

32 Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in  
33 compliance with section 07 84 00 Fire Stopping.

### 34 35 **NON-RATED PENETRATIONS:**

36 At all interior walls and exterior walls, conduit penetrations are required to be sealed. Apply  
37 sealant to both sides of the penetration in such a manner that the annular space between the  
38 sleeve or cored opening and the conduit is completely blocked.

### 39 40 **PENETRATIONS SUBJECT TO WATER INTRUSION:**

41 For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms  
42 housing electrical equipment (but not within walls) provide one of the following:

- 43 • Conduit penetration where steel pipe sleeve is used extend steel sleeve 2" above the  
44 floor.
- 45 • Conduit penetration where cast in place fire stopping device/sleeve is used, extend  
46 device/sleeve 2" above the floor (provided it meets the device's UL listing).
- 47 • Conduit penetration where there is no steel sleeve or cast in place fire stopping  
48 device/sleeve, provide 2"x 2" x 1/8" galvanized steel angles fastened to floor surrounding  
49 the penetration or group of penetrations to prevent water from getting to penetration.  
50 Provide urethane caulk between angles and floor and fasten angles to floor minimum  
51 8" on center. Seal corners water tight with urethane caulk.

52  
53 Floors subject to water intrusion or rooms housing electrical equipment include the following  
54 locations:

- 55 • Restrooms
- 56 • Janitor Rooms w/ Sinks
- 57 • Mechanical/Plumbing Equipment Rooms
- 58 • Maintenance/Industrial Shops

- Vehicle Storage and Parking Ramps
- Data/Telecommunications Rooms
- Electrical Equipment Rooms

Provide waterproof caulk sealant top coating on fire stopping system (or other approved means to protect the fire stopping system from water) in areas subject to wash down such as Food Service and Dish Washing Areas.

#### **HOUSEKEEPING AND CLEAN UP**

The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

#### **AGENCY TRAINING**

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 2 hours.

**END OF SECTION**

DIVISION 26 – ELECTRICAL

**SECTION 26 05 04**  
**CLEANING, INSPECTION, AND TESTING OF ELECTRICAL EQUIPMENT**  
*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes the required cleaning, repair, adjustment, calibration, maintenance and testing of electrical equipment, as specified herein. This applies only to new electrical and existing electrical equipment being furnished, modified, worked on or serviced by this contractor for this project. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

General Inspection and Cleaning of all Equipment

Grounding Systems

Lightning/Surge Arresters

Mechanical and Electrical Interlock System

Panelboards

Cables

Light Fixtures

Occupancy Sensors

Battery Pack Emergency Lighting

Manual Transfer Switches

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process

**PART 2 - PRODUCTS**

Not Used.

**PART 3 - EXECUTION**

**GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT**

Inspect for physical damage and abnormal mechanical and electrical conditions.

Any item found to be out of tolerance, or in any other way defective as a result of the required testing, shall be reported to the DFD. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.

Compare equipment nameplate information with the latest single line diagram and report any discrepancies.

Verify proper auxiliary device operation and indicators.

Check tightness of accessible bolted electrical joints. Use torque wrench method.

Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.

1  
2 Make a close examination of equipment and remove any dirt or other forms of debris that may  
3 have collected in existing equipment or in new equipment during installation.  
4

5 **Clean All Equipment:**

6 Vacuum inside of panelboards, comm/data, security panel, etc.

7 Loosen attached particles and vacuum them away.

8 Wipe all insulators with a clean, dry, lint free rag.

9 Clean insulator grooves.

10 Re-vacuum inside surfaces as directed by the DFD Construction Representative or

11 Inspector  
12

13 Inspect equipment anchorage.  
14

15 Inspect equipment and bus alignment.  
16

17 Check all heater elements for operation and control.  
18

19 Lubricate nonelectrical equipment per manufacturer's recommendations.  
20

21 **GROUNDING SYSTEMS**

22 Inspect the ground system for adequate termination at all devices.  
23

24 **LIGHTNING/SURGE ARRESTERS**

25 Inspect for physical damage such as chipped or fractured porcelain. Wipe clean.  
26

27 Perform a ground continuity test to ground system.  
28

29 Verify the proper mounting and adequate clearance.  
30

31 Verify the voltage of the units with system one line diagram. Report any discrepancies.  
32

33 Verify that the electronic surge protection is connected properly and status lights are normal.  
34

35 Verify and compare measured values with manufacturer's specifications.  
36

37 **MECHANICAL AND ELECTRICAL INTERLOCK SYSTEM**

38 Physically test each system to insure proper function, operation and sequencing.  
39

40 Closure attempt shall be made on locked open devices.  
41

42 Opening attempt shall be made on locked closed devices.  
43

44 Key exchange shall be made with devices operated in off normal positions.  
45

46 **PANELBOARDS**

47 Torque all the connections per the manufacturers spec. Verify phase wires, color coding,  
48 separate neutral and mechanical bonding. Verify circuit breaker operation. Verify the directory.  
49

50 **CABLES**

51 Visual and Mechanical Inspections:

52 Inspect exposed sections for physical damage.

53 Verify cable is supplied and connected in accordance with single line diagram.

54 Inspect for shield grounding, cable support and termination.

55 Inspect for visual jacket and insulation condition.

56 Electrical Tests -- Below 600 Volts:

57 All secondary cables from the substation transformers to the secondary switchboards  
58 shall be subjected to insulation tests using a 500 vdc megger.

59 Visually inspect cables, lugs, connectors and all other components for physical damage  
60 and proper connections

- 1 Check all cable connectors for tightness(with a torque wrench) and clearances. Torque  
2 test conductor and bus terminations to manufacturer's recommendations.  
3 Check for proper grounding resistance at all services and at transformers. Resistance  
4 shall be 2 ohms maximum.  
5
- 6 **LIGHT FIXTURES**  
7 Check the bonding and proper lamping. Verify that recessed fixtures are installed with hold down  
8 clips. Confirm operation of the fixture with the proper switch or sensor.  
9
- 10 **OCCUPANCY SENSORS**  
11 Confirm operation of the sensor per the manufacturers spec.  
12
- 13 **BATTERY PACK EMERGENCY LIGHTING**  
14 Verify the operation per the manufacturers spec and run all of the diagnostic steps. Confirm  
15 proper grounding and location.  
16
- 17 **MANUAL TRANSFER SWITCHES**  
18 Verify the operation per the manufacturers recommendations. Confirm proper grounding and  
19 location. Verify phase wires, color coding, separate neutral and mechanical bonding.  
20  
21  
22
- END OF SECTION**

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DIVISION 26 – ELECTRICAL

**SECTION 26 05 19**

**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes furnishing and installing required wiring and cabling systems including pulling, terminating and splicing. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- References
- Submittals
- Project Conditions

**PART 2 - PRODUCTS**

- General
- Building Wire
- Service Entrance Conductors
- Underground Wire for Exterior Work
- Wiring Connectors

**PART 3 - EXECUTION**

- General Wiring Methods
- Wiring Installation In Raceways
- Wiring Connections and Terminations
- Field Quality Control
- Wire Color
- Branch Circuits
- Construction Verification Items

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

- Section 01 91 01 or 01 91 02 - Commissioning Process
- Section 01 91 01 - Commissioning Process
- Section 26 05 33 - Raceway and Boxes for Electrical Systems
- Section 26 05 53 - Identification for Electrical Systems
- Section 26 08 00 - Commissioning of Electrical

**REFERENCES**

NFPA 70 - National Electrical Code.

**SUBMITTALS**

Submit product data: Provide for each cable assembly type.

Submit factory test reports: Indicate procedures and values obtained.

Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

**PROJECT CONDITIONS**

Verify that field measurements are as shown on Drawings.

Conductor sizes are based on copper.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.

Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

## **PART 2 - PRODUCTS**

### **GENERAL**

All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

All conductors shall be copper. Aluminum conductors size #1/0 and larger may be substituted for copper and used for phase and neutral conductors for transformer feeders, switchboard feeders, and panelboard feeders. All ground conductors shall be copper.

Aluminum conductors shall not be used for serving individual motors, chillers, VFD's and motor controllers.

The following requirements shall be met when aluminum conductors are used:

Aluminum alloy conductors shall be compact stranded conductors of a recognized Aluminum Association 8000 Series aluminum alloy conductor material (AA-8000 series alloy).

It is the responsibility of the contractor to increase the size of the conduit, wire gutter, or enclosure, if necessary, to accommodate the aluminum conductors and meet allowable code requirements.

It is the responsibility of the contractor to increase the size of the aluminum conductor to match the ampacity of the copper conductor circuit shown on the Drawings.

The contractor shall submit a feeder schedule to the Engineer for all conductor substitutions indicating the aluminum conductor wire size and the conduit size. The contractor shall not begin the installation until written approval is granted by the Engineer.

All aluminum conductors shall terminate on a mechanical screw-type connector or mechanical compression-type connector. Connector shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors, and sized to accept aluminum conductors of the required ampacity. When using compression-type connectors, the lugs shall be marked with wire size, die index, number and location of crimps and shall be suitably color-coded. Using a suitable stripping tool, remove insulation from the required length of the conductor. Wire brush the conductor and apply a Listed joint compound. Tighten or crimp the connection per the connector manufacturer's recommendation. Wipe off any excess joint compound.

When terminating aluminum conductors to aluminum bus, prepare a mechanical screw-type or compression-type connection. Bolts shall be anodized alloy and conform to current ANSI and ASTM chemical and mechanical property limits. Nuts shall be aluminum alloy and conform to current ANSI standards. Washers shall be flat aluminum alloy, Type A plain, standard wide series conforming to current ANSI standards. Lubricate and tighten the hardware per manufacturer's recommendations.

When terminating aluminum conductors to copper bus, prepare a mechanical screw-type or compression-type connection. Bolts shall be plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to current ASTM standard or SAE grade 5. Nuts shall conform to current ANSI standards. Washers shall be steel, Type A plain, standard wide series conforming to current ANSI standards. Belleville conical spring washers shall be of hardened steel, cadmium plated or silicone bronze. Lubricate and tighten the hardware per manufacturer's recommendations.

The final tightening torque shall be recorded for all aluminum conductor mechanical screw-type connections and provided in report form, in the completed O&M manuals.



1 The contractor shall perform an infrared survey of all aluminum conductor connections  
2 after the installation is complete and in normal service. Infrared surveys shall be  
3 performed during periods of maximum possible loading with at least 30% of rated load of  
4 the equipment being inspected. All connections with elevated temperatures shall be  
5 corrected by the contractor. The infrared survey results shall be provided in report form,  
6 in the completed O&M manuals.  
7  
8 **No copper-to-aluminum transitions permitted when splicing onto existing copper**  
9 **feeders.**  
10  
11 Insulation shall have a 600 volt rating.  
12  
13 All conductors shall be stranded.  
14  
15 Stranded conductors may only be terminated with UL OR ETL Listed type terminations or  
16 methods: e.g. stranded conductors may not be wrapped around a terminal screw but  
17 must be terminated with a crimp type device or must be terminated in an approved back  
18 wired method.  
19  
20 **BUILDING WIRE**  
21 Description: Single conductor insulated wire 90 degree C.  
22  
23 Insulation: Type THHN/THWN-2, XHHW-2 insulation.  
24  
25 **SERVICE ENTRANCE CONDUCTORS**  
26 Description: Single conductor or multi-conductor insulated wire. 90 degree C sized at the 75  
27 degree C table.  
28  
29 Insulation: Type USE-2, XHHW-2 insulation for service entrance conductors routed from exterior  
30 source to exterior termination location.  
31 Type XHHW-2 insulation for services entrance conductors routed from exterior source to  
32 interior termination location.  
33  
34 **ABOVE GROUND WIRE FOR EXTERIOR WORK**  
35 Description: Single conductor insulated wire, 90 degree C.  
36  
37 Insulation: Type THHN/THWN-2, XHHW-2 insulation.  
38  
39 **UNDERGROUND WIRE FOR EXTERIOR WORK**  
40 Description: Stranded single or multiple conductor insulated wire, 90 degree C.  
41  
42 Insulation: Type USE-2, XHHW-2, RHW-2 insulation.  
43  
44 This wiring shall be used in all underground feeder and branch circuit applications, except  
45 THHN/THWN-2 is permitted when run in a concrete-encased ductbank.  
46  
47 **WIRING CONNECTORS**  
48 Split Bolt Connectors: Not acceptable.  
49  
50 Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable  
51 termination to equipment terminals. Not approved for splicing.  
52  
53 Twist Type Wire Connectors: Solderless twist type spring connector (wire-nut) with insulating  
54 cover for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller. The  
55 manufacturer's wire fill capacity must be followed.  
56  
57 All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors  
58 or a connector designed for damp and wet locations. Gel filled twist type connectors can be used  
59 for copper conductor sizes 6 AWG and smaller for site lighting applications. The manufacturer's  
60 wire fill capacity must be followed.  
61  
62 Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between  
63 conductors; beveled cable entrances.  
64

1 Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing;  
2 internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and  
3 proper number and location of crimps. Connector must be installed with a crimper tool listed for  
4 use with the manufacturer and type of compression connector.

5  
6 Insulation Piercing Connectors: Molded insulated body, copper teeth, wrench tightened, UL 486B  
7 Listed. May be used only for connection of a tap conductor in run and tap type applications when  
8 main conductor is 8 AWG and larger.

### 11 **PART 3 - EXECUTION**

#### 13 **GENERAL WIRING METHODS**

14 All wire and cable shall be installed in conduit.

15  
16 Do not use wire smaller than 12 AWG for power and lighting circuits.

17  
18 All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a  
19 minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than  
20 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61  
21 m).

22  
23 Make conductor lengths for parallel conductors equal.

24  
25 Splice only in junction or outlet boxes.

26  
27 No conductor less than 10 AWG shall be installed in exterior underground conduit.

28  
29 Identify ALL low voltage, 600v and lower, wire per section 26 05 53.

30  
31 Neatly train and lace wiring inside boxes, equipment, and panelboards.

#### 33 **WIRING INSTALLATION IN RACEWAYS**

34 Pull all conductors into a raceway at the same time. Use Listed water or silicone based wire  
35 pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary.  
36 Wax based lubricants are not allowed. Pulling lubricant is not required for low friction type  
37 products where the cable manufacturer recommends that cables be pulled without lube.

38  
39 Install wire in raceway after interior of building has been physically protected from the weather  
40 and all mechanical work likely to injure conductors has been completed.

41  
42 Completely and thoroughly swab raceway system before installing conductors.

43  
44 Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground  
45 conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an  
46 equal number of phase and neutral conductors in same raceway or cable.

47  
48 In high ambient spaces, mechanical rooms, utility rooms and exterior exposed conduit, 90 degree  
49 C conductors shall be utilized.

#### 51 **WIRING CONNECTIONS AND TERMINATIONS**

52 Splice only in accessible junction boxes.

53  
54 Wire splices and taps shall be made firm, and adequate to carry the full current rating of the  
55 respective wire without soldering and without perceptible temperature rise.

56  
57 All splices shall be so made that they have an electrical resistance not in excess of two feet (600  
58 mm) of the conductor.

1 Use solderless twist type spring connectors (wire nuts) with insulating covers for wire splices and  
2 taps, 10 AWG and smaller.

3  
4 Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape  
5 uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value  
6 of conductor.

7  
8 Thoroughly clean wires before installing lugs and connectors.

9  
10 At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

### 11 12 **FIELD QUALITY CONTROL**

13 Field inspection and testing will be performed under provisions of Section 26 05 04.

14  
15 Additional testing as follows shall be performed if aluminum conductors are used:

- 16 1. Equipment terminated with aluminum conductors shall be tested with a thermal  
17 imager and recorded.
- 18 2. Conductors shall be closely checked for loose or poor connections, and for signs  
19 of overheating or corrosion.
- 20 3. Test procedures shall meet NETA guidelines.
- 21 4. Test results and report shall be provided to the engineer.
- 22 5. Contractor shall correct all deficiencies reported in the test report.

### 23 24 **WIRE COLOR**

25 General:

- 26 1. Solid colored insulation is required for all THHN/THWN-2 wire. For other wire  
27 types use colored wire or identify wire with colored tape at all terminals, splices  
28 and boxes. Wire shall be colored as indicated below.
- 29 2. In new facilities, use black and red for single phase circuits at 120/240 volts, use  
30 Phase A black, Phase B red.  
31 Note: This includes fixture whips except for Listed whips mounted by the fixture  
32 manufacturer on the fixture and Listed as a System.
- 33 3. All switch legs shall be the same color as their associated circuit. Traveler  
34 conductors run between 3 and 4 way switches shall be colored pink or purple.

35  
36 Neutral Conductors: White for 120/240V systems. Where there are two or more neutrals in one  
37 conduit, each shall be individually identified with a different stripe.

38  
39 Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color  
40 coded.

41  
42 Feeder Circuit Conductors: Each phase shall be uniquely color coded.

43  
44 Ground Conductors: Green colored insulation for THHN/THWN-2 wire. For other wire types use  
45 green colored wire or identify wire with green tape at both ends and at all access points, such as  
46 panelboards, motor starters, disconnects and junction boxes. When isolated grounds are  
47 required, contractor shall provide green with yellow tracer.

### 48 49 **BRANCH CIRCUITS**

50 The use of single-phase, multi-wire branch circuits with a common neutral is not permitted. All  
51 single-phase branch circuits shall be furnished and installed with an individual accompanying  
52 neutral, sized the same as the phase conductors.

### 53 54 **CONSTRUCTION VERIFICATION**

55 Contractor is responsible for utilizing the construction verification checklists supplied under  
56 specification Section 26 08 00 in accordance with the procedures defined for construction  
57 verification in Section 01 91 01 or 01 91 02.

58  
59 **END OF SECTION**

DIVISION 26 – ELECTRICAL

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes grounding electrodes and conductors, equipment grounding conductors, and bonding. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- References
- Performance Requirements
- Submittals
- Project Record Documents
- Regulatory Requirements

**PART 2 - PRODUCTS**

- Rod Electrode
- Concrete-Encased Grounding Electrode
- Mechanical Connectors
- Compression Connectors
- Exothermic Connections
- Conductors
- Bus/Busbar

**PART 3 - EXECUTION**

- Examination
- General
- Less Than 600 Volt System Grounding
- Communication System Grounding
- Field Quality Control
- Identification and Labeling
- Construction Verification Items

All hardware, cables and related termination and support hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in this and related sections.

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 26 08 00 - Commissioning of Electrical.  
Section 01 91 01 or 01 91 02 – Commissioning Process

**REFERENCES**

- NFPA 70 - National Electrical Code
- ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems
- UL 467 Electrical Grounding and Bonding Equipment
- ANSI J-STD-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- TIA/EIA-606-A - Administration Standard for Commercial Telecommunications Infrastructure

**PERFORMANCE REQUIREMENTS**

Grounding System Resistance:

- Equipment Rated 500 KVA and Less: 10 ohms maximum at building service entrance.
- Equipment Rated 500 to 1000 KVA: 5 ohms maximum at building service entrance.
- Equipment Rated more than 1000 KVA: 3 ohms building service entrance.
- Communications Busbars: 5 ohms maximum.

Testing of grounding system resistance is to be witnessed by the DSF electrical inspector or Field Representative. Provide test report of grounding system resistance in final O&M manuals.

### Grounding System Resistance:

- Equipment Rated 500 KVA and Less: 10 ohms maximum at building service entrance.
- Equipment Rated 500 to 1000 KVA: 5 ohms maximum at building service entrance.
- Equipment Rated more than 1000 KVA: 3 ohms building service entrance.
- Communications Busbars: 5 ohms maximum.

Testing of grounding system resistance is to be witnessed by the DFD electrical inspector or Field Representative. Provide test report of grounding system resistance in final O&M manuals.

### **SUBMITTALS**

Product Data: Provide data for grounding electrodes and connections.

Test Reports: Indicate overall resistance to ground [and resistance of each electrode].

Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

### **PROJECT RECORD DOCUMENTS**

Accurately record actual locations of grounding electrodes.

### **REGULATORY REQUIREMENTS**

Conform to requirements of NFPA 70.

Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

## **PART 2 - PRODUCTS**

### **ROD ELECTRODE**

Material: Copper-clad steel.

Diameter: 3/4 inch (19 mm) minimum.

Length: 10 feet (3.5 m) minimum. Rod shall be driven at least 9' 6" deep.

### **CONCRETE-ENCASED GROUNDING ELECTRODE**

Fabricate per NFPA 70, Article 250.52 (A)(3) using 20 feet (6m) of bare copper wire not smaller than #4 AWG. If concrete foundation is less than 20 feet (6m) long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts.

### **MECHANICAL CONNECTORS**

The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.

Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.

The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

### **COMPRESSION CONNECTORS**

The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.

Each connector shall be factory filled with an oxide-inhibiting compound.

The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

The installation of the connectors shall be made with a compression tool and die system, as recommended by the manufacturer of the connectors.

Pre-crimping of the ground rod is required for all irreversible compression connections to a ground rod.

Terminal lug for communication system grounding shall be compression type and conform to the following:

Material: Tin Plated Copper (aluminum not permitted).

Wire Size: to match conductor

Number of Stud Holes: 2

Stud Hole Size: 3/8"

Bolt Hole Spacing: per ANSI Joint Standard J-STD-607-A

Tongue Angle: Straight

### **EXOTHERMIC CONNECTIONS**

As manufactured by Cadweld or similar.

### **CONDUCTORS**

Material: Stranded copper (aluminum not permitted).

Grounding Electrode Conductor: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.

Foundation Electrodes: As shown on drawings.

Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used at the same facility.

Conductors for Telecommunications shall be as follows:

Telecommunications Bonding Conductor (TMGB to Service Ground): No. 3/0 minimum or as shown on drawings.

Telecommunications Bonding Backbone (TBB; TMGB to TGB): No. 3/0 minimum or as shown on drawings.

Telecommunications Grounding Equalizer (GE): No. 3/0 minimum or as shown on drawings.

Bonding Conductors shall be insulated with a Green Jacket or jacket marked with Green Tape or labeled per NEC Guidelines

### **BUS/BUSBAR**

Material: Copper (aluminum not permitted).

Size: All Power systems: 1/4" X 2", length as needed (24" minimum).

Telecommunications Main Ground Busbar (TMGB): 1/4" x 4" x 20" long (minimum).

Telecommunications Grounding Busbar (TGB): 1/4" x 2" x 12" long (minimum).

Busbars for Telecommunications shall:

Be pre-drilled to accommodate two-hole lugs.

3/8" stud hole size; hole spacing per ANSI J-STD-607-A.

Incorporate insulators and stand-off brackets that electrically isolate busbar from mounting surface.

Provide main ground busbar located adjacent to main electrical service equipment to terminate all ground conductors. Refer to DFD grounding detail 26 05 26-1.

## **PART 3 - EXECUTION**

### **EXAMINATION**

Verify that final backfill and compaction has been completed before driving rod electrodes.

### **GENERAL**

Install Products in accordance with manufacturer's instructions.

Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.

Attach grounds permanently before permanent building service is energized.

Terminate each grounding conductor on its own terminal lug. Sharing a single lug by multiple conductors is not allowed.

All grounding electrode conductors and individual grounding conductors shall be installed in PVC conduit, in exposed locations.

### **LESS THAN 600 VOLT ELECTRICAL SYSTEM GROUNDING**

Supplementary Grounding Electrode: Use driven ground rod on exterior of building.

Provide code sized copper grounding electrode conductor from electrical room ground bus to secondary switchboard ground bus, each separately derived system neutral, secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes. Provide bonding jumper around water meter.

Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.

Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

Install ground grid under access floors where indicated. Construct grid of #4 AWG bare copper wire installed on 72 inch centers both ways. Bond each access floor support pedestal to grid.

Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to under floor ground grid. Use #4 AWG bare copper conductor.

### **COMMUNICATION SYSTEM GROUNDING**

Grounding and Bonding System for Communications shall be an isolated grounding system with a single ground point. That ground point is to be the common grounding electrode system at the building electrical service entrance (main ground bar located in electrical room).

The system shall be compliant with ANSI J-STD-607-B with the exception that the ground cable shall not be bonded to building steel except at the electrical service entrance.

Provide Grounding Busbar for Telecommunications at each Telecommunications Room, the Main Equipment Room and at the electrical service entrance per project drawings. Coordinate Busbar location(s) and conductor routing per drawings with Division 27 contractor.

Provide Telecommunications Bonding Conductor from Telecommunications Main Grounding Busbar (TMGB) at the Communications Entrance Facility to building common grounding electrode system. Attach grounding conductor to building steel as allowed only at the main electrical service entrance.

1 Provide Telecommunications Bonding Backbone (TBB) conductor from the TMGB to  
2 Telecommunications Grounding Busbar (TGB) at each Telecommunication Room,  
3 Telecommunications Equipment Room and Telecommunications Enclosure.  
4 • TBB shall be continuous and not connected through Telecommunications  
5 Grounding Busbars (TGBs).  
6 • Bond TGBs to TBB via tap off of TBB. Gauge of conductor to be same at TBB.  
7 • Leave 10 feet slack in conductor from TBB to TGB at TGB location(s).  
8 • Do not bond TBB or TGB to building steel at TGB location(s).

9  
10 Provide Grounding Equalizer(s) (GE) per project drawings. Connect GE conductor directly to  
11 TGBs being interconnected.

### 12 13 **FIELD QUALITY CONTROL**

14 Inspect grounding and bonding system conductors and connections for tightness and proper  
15 installation.

### 16 17 **IDENTIFICATION AND LABELING**

18 Label Grounds at point of termination.

19  
20 Label the connections from the Telecommunications Bonding Backbone (TBB) conductor to the  
21 Telecommunications Main Grounding Busbar (TMGB) and the Telecommunications Grounding  
22 Busbar TGB(s). The label shall be plastic and include the following:

23  
24  
25 IF THIS CONNECTOR OR CABLE IS  
26 LOOSE OR MUST BE REMOVED,  
27 PLEASE CALL THE BUILDING  
28 TELECOMMUNICATIONS  
29 MANAGER.  
30

### 31 **CONSTRUCTION VERIFICATION**

32 Contractor is responsible for utilizing the construction verification checklists supplied under  
33 specification Section 26 08 00 in accordance with the procedures defined for construction  
34 verification in Section 01 91 01 or 01 91 02.

35  
36 **END OF SECTION**  
37



DIVISION 26 – ELECTRICAL

**SECTION 26 05 29**  
**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**  
*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this sections includes conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Submittals
- Quality Assurance

**PART 2 - PRODUCTS**

- Material

**PART 3 - EXECUTION**

- Installation

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 - Commissioning Process

**SUBMITTALS**

Product Data: Provide data for support channel.

**QUALITY ASSURANCE**

Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

**PART 2 - PRODUCTS**

**MATERIAL**

Support Channel: Steel, Galvanized, Enameled or other corrosion resistant.

Hardware: Corrosion resistant.

Minimum sized threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and 1/4" for single conduits 1" and smaller.

Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.

**PART 3 - EXECUTION**

**INSTALLATION**

Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using pre-cast insert system, preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only).

Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable type anchors.

**Powder-actuated fasteners and plastic wall anchors are not permitted. Compressed-air power-actuated fasteners may ONLY be used for the installation of separate ceiling wires required for support of conduits and aircraft cable hung light fixtures.**

1 File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent  
2 rusting.  
3  
4 Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not  
5 fasten to suspended ceiling grid system.  
6  
7 Do not drill structural steel members unless approved by DSF.  
8  
9 Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to  
10 present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.  
11  
12 In wet locations, mechanical rooms and electrical rooms install free-standing electrical equipment  
13 on 3.5 inch (89 mm) concrete pads.  
14  
15 Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel  
16 channel supports to stand cabinet one inch (25 mm) off wall (7/8" Uni-strut or 3/4" painted, fire-  
17 retardant plywood is acceptable).  
18  
19 Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in  
20 stud walls.  
21  
22 Furnish and install all supports as required to fasten all electrical components required for the  
23 project, including free standing supports required for those items remotely mounted from the  
24 building structure, catwalks, walkways etc.  
25  
26  
27

**END OF SECTION**

DIVISION 26 – ELECTRICAL

**SECTION 26 05 33**  
**RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes conduits, surface raceways, multi-outlet assemblies, auxiliary gutters, wall duct, and boxes for electrical systems including wall and ceiling outlet boxes, floor boxes, and junction boxes. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Submittals

**PART 2 - PRODUCTS**

- Rigid Metal Conduit (RMC) and Fittings
- PVC Coated Rigid Metal Conduit
- Intermediate Metal Conduit (IMC) and Fittings
- Electrical Metallic Tubing (EMT) and Fittings
- Flexible Metal Conduit (FMC) and Fittings
- Liquidtight Flexible Metal Conduit (LFMC) and Fittings
- Electrical Nonmetallic Tubing (ENT) and Fittings
- Rigid Polyvinyl Chloride Conduit (PVC) and Fittings
- Conduit Supports
- Auxiliary Gutters (Wireways)
- Pull and Junction Boxes
- Outlet Boxes
- Floor Boxes
- General

**PART 3 - EXECUTION**

- Conduit Sizing, Arrangement and Support
- Conduit Installation
- Conduit Installation Schedule
- Surface Metal Raceway and Multi-Outlet Assembly Installation
- Nonmetallic Surface Raceway Installation
- Coordination of Box Locations
- Pull and Junction Box Installation
- Outlet Box Installation
- Floor Box Installation
- Construction Verification Items

**PART 3 - EXECUTION**

- Conduit Sizing, Arrangement and Support
- Conduit Installation
- Conduit Installation Schedule
- Surface Metal Raceway Installation
- Coordination of Box Locations
- Outlet Box Installation
- Floor Box Installation
- Pull and Junction Box Installation
- Construction Verification Items

**RELATED WORK**

Applicable provisions of Division 1 govern work under this section.

Section 01 91 01 or 01 91 02 - Commissioning Process  
Section 26 05 29 - Hangers and Supports for Electrical Systems  
Section 26 08 00 - Commissioning of Electrical.  
Section 26 27 02 - Equipment Wiring Systems.  
Section 26 27 26 - Wiring Devices.  
Section 27 00 00 - Communications Cable and Equipment.  
Section 26 27 26 - Wiring Devices.

**SUBMITTALS**

Surface Raceway System - submit product data and catalog sheets for all components.

Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

## **PART 2 - PRODUCTS**

### **RIGID METAL CONDUIT AND FITTINGS**

Conduit: Heavy wall, galvanized steel, schedule 40, threaded.

Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

### **PVC COATED RIGID METAL CONDUIT**

PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.

Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.

### **INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS**

Conduit: Galvanized steel, threaded.

Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

### **ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS**

Conduit: Steel, galvanized tubing.

Fittings: All steel, set screw, concrete tight. No push-on or indenter types permitted.

Conduit Bodies: All steel threaded conduit bodies.

### **FLEXIBLE METAL CONDUIT AND FITTINGS**

Conduit: steel, galvanized, spiral strip.

Fittings and Conduit Bodies: All steel, galvanized, or malleable iron (except as allowed in specification 26 51 13).

### **LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS**

Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

### **ELECTRICAL NONMETALLIC TUBING (ENT) AND FITTINGS**

Conduit: ENT (smurf tube), UL listed and NEC recognized.

Fittings: One piece quick connect fittings for 1/2 inch to 1 inch size and schedule 40 cemented fittings for larger size. When installed in concrete, fittings shall be suitable for damp locations and shall be concrete-tight, stub-ups and stub-downs kits shall meet manufacturer's recommendations.

### **RIGID NONMETALLIC CONDUIT AND FITTINGS**

Conduit: Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90° C conductors.

Fittings and Conduit Bodies: NEMA TC 2, Listed.

### **RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS**

Conduit: Rigid non-metallic conduit, Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90° C conductors.

Fittings and Conduit Bodies: NEMA TC 2, Listed.

## **CONDUIT SUPPORTS**

See section 26 05 29.

#### **OUTLET BOXES**

Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.

Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.

Concrete Ceiling Boxes: Concrete type.

Cast Boxes: Cast ferroalloy, or aluminum type deep type, gasketed cover, threaded hubs.

#### **FLOOR BOXES**

Floor Boxes for Installation in Cast-In-Place Concrete Floors: Full adjustable cast iron or formed steel.

Walker 880 series or approved equal. Refer to Electrical Schedules for specific floor box requirements.

Concrete tight, compatible carpet or tile cover plate for service provided. Finish color of cover plate to be selected by Architect from standard cover plate options.

Separate power, data and voice compartments, where applicable.

Provide telecommunications outlet accessory with faceplate, insert and connections compatible with the box service, and that the cable minimum bend radius and space for terminations adequate.

#### **PULL AND JUNCTION BOXES**

Interior Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

Interior Sheet Metal Boxes Larger Than 12 Inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.

Exterior Boxes and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. [Galvanized cast iron][aluminum box] [PVC] and cover with ground flange, neoprene gasket, and stainless steel cover screws.

Fiberglass, Quazite or Concrete Handholes with weatherproof cover of non-skid finish shall be used for underground installations. Cover shall identify system serviced.

Box extensions and adjacent boxes within 48" of each other are not allowed for the purpose of creating more wire capacity.

Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.

Wireways shall not be used in lieu of junction boxes.

#### **OUTLET BOXES**

Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.

Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.

Concrete Ceiling Boxes: Concrete type.

Cast Boxes: Cast ferroalloy, or aluminum type deep type, gasketed cover, threaded hubs.

#### **FLOOR BOXES**

Floor Boxes for Installation in Cast-In-Place Concrete Floors: Full adjustable, cast iron, formed steel, PVC.

Floor Boxes for installation in existing floors shall be poke-thru type. [1 hour] [2 hour] [3 hour] to match rating of existing floor. Floor box shall utilize 3" cores. Universal covers shall be Brass.

Refer to Electrical Schedules for specific floor box requirements.

#### GENERAL

All steel fittings and conduit bodies shall be galvanized.

No cast metal or split-gland type fittings permitted.

Mogul-type condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.

All condulet covers must be fastened to the condulet body with screws and be of the same manufacture.

Wireways, gutters and c-condulets shall not be used in lieu of pull boxes and condulets.

All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

#### PART 3 - EXECUTION

##### CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

EMT is permitted to be used in sizes 4" (50 mm) and smaller for power and low-voltage systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.

Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (16 mm) minimum except **all homerun conduits shall be 3/4" (21 mm)**, or as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**

Size communications and other low-voltage systems raceways as follows:

Communications, including Outlet Box-1-1/4 inch. 3/4 inch conduit may be used for single device locations (e.g. Wireless Access Point, Video Surveillance Camera, and Wall mounted telephone).

Control, security, fire alarm, signal, video and other low-voltage applications - 3/4 inch.

Provide one raceway from each communications outlet box [to above accessible ceiling] [to cable tray].

Arrange conduit to maintain headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.

1 Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers)  
2 constructed of steel channel with conduit straps or clamps. Provide space for 25 percent  
3 additional conduit.

4  
5 Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove  
6 all wire used for temporary conduit support during construction.

7  
8 Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.

9  
10 Supports shall be independent of the installations of other trades, e.g. ceiling support wires,  
11 HVAC pipes, other conduits, etc., unless so approved or detailed.

12  
13 In general, all conduit shall be concealed except where noted on the drawings or approved by the  
14 Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations  
15 except in mechanical rooms.

16  
17 Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal  
18 boxes or cast steel conduit bodies.

19  
20 For indoor conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a  
21 junction box.

22  
23 All conduits installed in exposed areas shall be installed with a box offset before entering box.

#### 24 25 **CONDUIT INSTALLATION**

26 Cut conduit square; de-burr cut ends.

27  
28 Conduit shall not be fastened to the corrugated metal roof deck.

29  
30 Bring conduit to the shoulder of fittings and couplings and fasten securely.

31  
32 Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for  
33 fastening conduit to sheet metal boxes in damp or wet locations.

34  
35 Terminate all conduit (except for terminations into conduit bodies) using conduit hubs, or  
36 connectors with one locknut, or utilize double locknuts (one each side of box wall).

37  
38 Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 26 05  
39 26 - Grounding and Bonding for Electrical Systems for grounding bushing requirements.

40  
41 Provide insulated bushings where raceways contain 4 AWG or larger conductors.

42  
43 Install no more than the equivalent of:

- 44
- 45 • Three 90 degree bends between boxes for electrical systems.
  - 46 • Two 90 degree bends between boxes for communications and other low voltage
  - 47 systems.
- 48

49 Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch  
50 (50 mm) size unless sweep elbows are required.

51  
52 Bend conduit according to manufacturer's recommendations. Torches or open flame shall not be  
53 used to aid in bend of PVC conduit.

54  
55 Use suitable conduit caps or other approved seals to protect installed conduit against entrance of  
56 dirt and moisture.

57  
58 Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.

1 Install expansion-deflection joints where conduit crosses building expansion joints. Note:  
2 expansion-deflection joints are not required where conduit crosses building control joints if the  
3 control joint does not act as an expansion joint.  
4  
5 Install expansion fitting in exterior PVC conduit runs per NEC table 352.44 utilizing a minimum  
6 temperature change of 120 degree F.  
7  
8 Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction  
9 boxes with drain fittings at conduit low points.  
10  
11 Where conduit passes between areas of differing temperatures such as into or out of cool rooms,  
12 freezers, unheated and heated spaces, buildings, etc., provide Listed conduit seals to prevent the  
13 passage of moisture and water vapor through the conduit.  
14  
15 Route conduit through roof openings for piping and ductwork where possible.  
16  
17 Where communication cabling is to be installed in conduit to the wiring hub (e.g. Telcom Room),  
18 multiple conduits may be consolidated into fewer, larger conduits. Capacity of shared conduits  
19 shall equal the capacity of the individual conduits unless otherwise noted.  
20  
21 Use U.L. listed metallic grounding clamps when terminating conduit to cable tray.  
22  
23 Ground and bond conduit under provisions of Section 26 05 26.  
24  
25 Conduit is not permitted in any slab topping of two inches (50 mm) or less.  
26  
27 Maximum Size Conduit in Slabs Above Grade: 3/4 inch (19 mm). Do not route conduits to cross  
28 each other in slabs above grade.  
29  
30 PVC conduit shall transition to galvanized rigid metal conduit, 12 inches before it enters a  
31 concrete pole base. Inside the pole base, the elbow shall be galvanized rigid metal conduit. Then  
32 the conduit shall transition back to PVC up and out of the top of the concrete pole base.  
33  
34 PVC conduit shall transition to galvanized rigid metal conduit before it enters a foundation wall  
35 (where exposed) or up through a concrete floor.  
36  
37 Identify conduit under provisions of Section 26 05 53.  
38  
39 All conduit installed underground (exterior to building) shall be buried a minimum of 24" below  
40 finished grade, whether or not the conduit is concrete encased.  
41  
42 Clean PVC conduit with solvent, and dry before application of glue. The temperature rating of  
43 glue/cement shall match weather condition. Apply full even coat of cement/glue to entire area  
44 that will be inserted into fitting. The entire installation shall meet manufacturer's  
45 recommendations.  
46

#### 47 **CONDUIT INSTALLATION SCHEDULE**

48 Conduit other than that specified below for specific applications shall not be used.  
49  
50

- 51 • Underground Installations Within Five Feet (1.5 m) of Foundation Wall: Rigid metal  
52 conduit.
- 53 • Underground Installations More than Five Feet (1.5 m) From Foundation Wall: Rigid  
54 metal conduit, PVC-coated rigid metal conduit, Resin (RTRC)/ Fiberglass Conduit (BG) or  
55 Schedule 40 PVC conduit.
- 56 • Under Slab on Grade Installations: Rigid metal conduit or Schedule 40 PVC conduit.
- 57 • Exposed Outdoor Locations: Rigid metal conduit, Resin (RTRC/ Fiberglass conduit (AG)  
58 (XW).  
59



- 1 • Concealed in Concrete Walls: Rigid Metal Conduit, Schedule 40 PVC conduit, or
- 2 Electrical Nonmetallic Tubing (ENT).
- 3 • Concealed in Block Walls: Electrical metallic tubing, Schedule 40 PVC conduit. Electrical
- 4 Nonmetallic Tubing (ENT).
- 5 • Within Concrete Slab: Rigid Metal conduit or Schedule 40 PVC conduit.
- 6 • Wet Interior Locations: [Rigid metal conduit] [Schedule 40 PVC conduit] [PVC coated
- 7 rigid metal conduit] [Resin (RTRC)/ Fiberglass Conduit (AG)].
- 8 • Concealed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit,
- 9 Electrical metallic tubing, and Schedule 40 PVC conduit (Ground conductor).
- 10 • Exposed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit,
- 11 Electrical metallic tubing, and Schedule 40 PVC conduit (Ground conductor).
- 12 • Motor and equipment connections: Liquidtight flexible metal conduit (LFMC) (all
- 13 locations). Minimum length shall be one foot (300 mm), maximum length shall be three
- 14 feet (900 mm). Conduit must be installed perpendicular to direction of equipment
- 15 vibration to allow conduit to freely flex.
- 16 • Light fixtures: Direct box or conduit connection for surface mounted and recessed
- 17 fixtures. Flexible metal conduit from a J-box for recessed lay-in light fixtures. Conduit
- 18 size shall be 3/8" (10 mm) minimum diameter and six foot (1.8 M) maximum length.
- 19 Conduit length shall allow movement of fixture for maintenance purposes.
- 20

## 21 **NONMETALLIC SURFACE RACEWAY INSTALLATION**

22 Use flat headed screws with appropriate anchors to fasten channel to surfaces secured every  
23 twenty-four (24) inches. Mount plumb and level. All surface mounted devices shall be fastened  
24 to the wall utilizing flat head screws along with appropriate anchors. No device shall be adhered  
25 to the wall surface using two-faced tape or any means other than as described above.

26  
27 Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

28  
29 In areas where the walls cannot be fished, the station cable serving these outlets shall be  
30 covered with raceways. No exposed wire shall be permitted within offices, laboratories, and  
31 conference rooms or like facilities.

32  
33 Non-metallic raceway shall have a screw applied base. Both the base and cover shall be  
34 manufactured of rigid PVC materials.

35  
36 The raceway shall originate from a surface mounted box mounted adjacent to and at the same  
37 height as existing electrical boxes in the room, be attached to the wall and terminate above the  
38 ceiling.

39  
40 All fittings including, but not limited to, extension boxes, elbows, tees, fixture bodies shall match  
41 the color of the raceway.

42  
43 The raceway and all systems devices shall be UL listed and exhibit nonflammable self-  
44 extinguishing characteristics, tested to specifications of UL94V-0.

45  
46 The communications and other low voltage systems raceway and devices shall adhere to the  
47 EIA/TIA Category 6 bend radius standard.

## 48 **COORDINATION OF BOX LOCATIONS**

49 Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling,  
50 equipment connections, and code compliance.

51  
52  
53 Electrical box locations shown on Contract Drawings are approximate unless dimensioned.  
54 Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

55  
56 No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment,  
57 piping, lockers, benches, counters, etc.

58

Conduit and boxes shall not be fastened to the metal roof deck. If conduit and boxes are required to be located and installed on roof decks, the conduit and boxes are required to be spaced minimum 1-5/8" off the lowest part of the metal roof decking material, per NEC 300.4 (E).

It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.

In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Architect/Engineer and install outlet as instructed by the Architect/Engineer.

The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.

Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors. Boxes must be installed within 12" from edge of the access door.

Locate and install to maintain headroom and to present a neat appearance.

Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

#### **PULL AND JUNCTION BOX INSTALLATION**

Pull boxes and junction boxes shall be minimum 4 inch square (100 mm) by 2 1/8 inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit, minimum junction box size shall be 4 11/16" by 2-1/8" deep.

Where used with raceway(s) of larger than 1 1/4" trade size or larger, pull box shall be sized as follows unless otherwise noted on the drawings:

- For straight pull through, have a length of at least 8-times trade-size diameter of largest raceway;
- For angle and U pulls:
  1. Have a distance between each raceway entry inside box and opposite wall of box of at least 6-times trade-size diameter of largest raceway, this distance being increased by sum of trade-size diameters of other raceways on same wall of box; and
  2. Have a distance between nearest edges of each raceway entry enclosing same conductor of at least six times trade-size diameter of raceway; or six times trade-size diameter of larger raceway if they are of different sizes.
- For a raceway entering wall of a pull box opposite to a removable cover, have a distance from wall to cover of not less than trade-size diameter of largest raceway plus 6-times diameter of largest conductor.

Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install DFD approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.

Provide Pull and Junction boxes for communications and other low voltage applications (a) in any section of conduit longer than 100 feet, (b) where there are bends totaling more than 180 degrees between pull points or pull boxes and (c) wherever there is a reverse bend in run. Locate boxes on straight section of raceway (e.g. do not use boxes in place of raceway bends).

Support pull and junction boxes independent of conduit.

#### **OUTLET BOX INSTALLATION**

Do not install boxes back-to-back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (600 mm) separation in acoustic-rated walls.

Power:

Recessed (1/4" maximum) outlet boxes in masonry, concrete, tile construction, or drywall shall be minimum 4 inch square, with device rings. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes. A single gang box can be used in drywall and masonry, for a single device location, when a single conduit enters box.

Shallow 4x4x1-1/2" deep boxes can be used as device boxes for power provided the box and plaster ring is sized for installed device and conductors.

Low Voltage:

Recessed (1/4" maximum) outlet boxes in masonry, concrete, tile construction or drywall shall be minimum 4 11/16 inch square, 2-1/8" deep with single gang device ring (unless noted otherwise on drawings). Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.

Provide one conduit from each communications outlet box. Conduit runs between outlet boxes for communications are not allowed. Terminate conduit [above accessible ceiling][above accessible ceiling in corridor][on cable tray][as detailed on drawings].

Provide knockout closures for unused openings.

Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.

Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide non-metallic barriers to separate wiring of different voltage systems.

Install boxes in walls without damaging wall insulation.

Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

Ceiling outlets shall be 4 inch square, minimum 2-1/8 inch (54 mm) deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.

In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.

Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.

Surface wall outlets shall be 4 inch (100 mm) square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.

**FLOOR BOX INSTALLATION**

Set boxes level and flush with finish flooring material.

Floor boxes for communications shall each be served by conduit(s) dedicated to that box. Conduit runs between floor boxes for communications are not allowed. Conduit shall be part of path that allows for cable to be terminated at wiring hub (e.g. Telecom Room) on same floor on which floor box appears unless noted otherwise.

#### **CONSTRUCTION VERIFICATION**

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

**END OF SECTION**

DIVISION 26 – ELECTRICAL

**SECTION 26 05 53**  
**IDENTIFICATION FOR ELECTRICAL SYSTEMS**  
*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes the products and execution requirements relating to labeling of power, control, and signal wiring. Further, this section includes the installation of labels, nameplates, and directories for electrical junction boxes, wiring devices, and electrical equipment. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Submittals

**PART 2 - PRODUCTS**

Materials

**PART 3 - EXECUTION**

General

Junction and Pullbox Identification

Communication Conduit Labeling

Power, Control and Signal Wire Identification

Wiring Device Identification

Nameplate Engraving For Electrical Equipment

Panelboard Directories

**RELATED WORK**

Applicable provisions of Division 1 shall govern work under this section.

Section 01 91 01 or 01 91 02 - Commissioning Process

Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

Section 26 05 23 - Control-Voltage Electrical Power Cables

Section 27 00 00 - Communications Cable and Equipment

**SUBMITTALS**

Include schedule for nameplates and stenciling.

Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2" x 11" sheets annotated, explaining their purposed use.

**PART 2 - PRODUCTS**

**MATERIALS**

Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.

All wiring labels shall be white/transparent vinyl or vinyl-cloth, self-laminating, wraparound type. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.

Tape (wiring phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.

Nameplates: Engraved three-layer laminated plastic. Normal system shall use nameplates with black letters on white background, emergency system (NEC 700) shall use white letters on red background, legally required standby system (NEC 701) shall use white letters on blue background, and optional standby system (NEC 702) shall use white letters on yellow background.

Adhesive type labels not permitted except for identification of wires, wiring devices (device plates), 8" square and smaller junction boxes, and control devices.

See Junction and Pullbox Identification and Wiring Device Identification sections for allowed usage of permanent marker.

### PART 3 - EXECUTION

#### GENERAL

Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system shall be labeled for voltage in addition to other requirements listed herein.

All branch circuit and power panels shall be identified with the same symbol used in circuit directory in main distribution center.

Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent. Install all labels firmly as recommended by the label manufacturer. Labels shall be installed plumb and neatly on all equipment.

Install nameplates parallel to equipment lines.

Secure nameplates to equipment fronts using screws, rivets or manufacturer approved adhesive or cement.

Embossed tape will not be permitted for any application.

Provide a sign at the service-entrance equipment indicating type and location of on-site emergency power sources and on-site legally required standby power sources, per NEC 700.7 and NEC 701.7.

Fire pump disconnects shall be marked as "Fire Pump Disconnecting Means", per NEC 695.4(B)(3)(c).

Provide a sign at each service disconnect indicating "Service Disconnect", and locate at the switch or circuit breaker, per NEC 230.70(B).

#### JUNCTION AND PULLBOX IDENTIFICATION

The following junction and pullboxes shall be identified utilizing spray painted covers:

<u>System</u>	<u>Color(s)</u>
Secondary Power – 208Y/120V, 240/120V	White
Data	Blue

Additional required junction and pullbox identification shall include:

Provide circuit numbers and source panel designations for power wiring junction boxes. Other system junction boxes shall be identified as shown on details or approved shop drawings.

Where exposed, junction boxes larger than 8" square shall utilize engraved nameplates with ½" minimum letter height. Identify system source(s) and load(s) served.

Where exposed, 8" square and smaller junction boxes shall utilize machine generated, adhesive labels.

Where located above an accessible ceiling, junction boxes may be neatly identified using a permanent marker.

#### COMMUNICATION CONDUIT LABELING

All conduits installed between Telecommunication Equipment Rooms shall be clearly labeled in accordance with ANSI/TIA/EIA-606. Both ends of the conduits shall be labeled.

All labels shall be mechanical, no hand written labels.

The label shall indicate the location of the far end of the conduit run and a unique conduit number. (i.e. TR-1A-01 or Room #216 – 01).

#### POWER, CONTROL AND SIGNAL WIRE IDENTIFICATION

1 Provide wire labels on each conductor in panelboard gutters, pull boxes, outlet and junction  
2 boxes, and at load connection. Identify with branch circuit or feeder number for power and  
3 lighting circuits, and with wire number as indicated on schematic and interconnection diagrams or  
4 equipment manufacturer's shop drawings for control and signal wiring.

5  
6 All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall  
7 be labeled as soon as it is terminated including wiring used for temporary purposes.

#### 8 **WIRING DEVICE IDENTIFICATION**

9  
10 Wall switches, receptacles, occupancy sensors, wall dimmers, device plates and box covers,  
11 poke-through fittings, access floor boxes, photocells, and time clocks shall be identified with  
12 circuit numbers and source (ex. Panel ABC-3). In exposed areas, identifications should be made  
13 inside of device covers, unless directed otherwise. Use machine-generated adhesive labels, or  
14 neatly hand-written permanent marker.

#### 15 **NAMEPLATE ENGRAVING FOR ELECTRICAL EQUIPMENT**

16 Provide nameplates of minimum letter height as scheduled below.

17  
18  
19 Distribution Panelboards, Branch Panelboards, Switchboards and Motor Control Centers: 1 inch  
20 (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and  
21 room location of the source. Panelboards serving NEC 700, 701 or 702 loads shall identify which  
22 branch they serve.

23  
24 Circuit Breakers, Switches, and Motor Starters in Distribution Panelboards, Switchboards and  
25 Motor Control Centers: 1/2 inch (13 mm); identify circuit and load served, including location.

26  
27 Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: 1/2 inch  
28 (13 mm); identify source and load served.

29  
30 Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary  
31 and secondary voltages, primary source and location, and secondary load and location.

#### 32 **PANELBOARD DIRECTORIES**

33  
34 Typed directories for panels must be covered with clear plastic, and have a metal frame. Room  
35 number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

36  
37  
38 **END OF SECTION**  
39

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DIVISION 26 – ELECTRICAL

**SECTION 26 08 00**  
**COMMISSIONING OF ELECTRICAL**  
*BASED ON DFD MASTER SPECIFICATION DATED 03/01/14*

**PART 1 - GENERAL**

**SCOPE**

This section includes commissioning forms for construction verification and functional performance testing. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Reference

Submittals

**PART 2 - PRODUCTS**

(Not Used)

**PART 3 – EXECUTION**

Commissioning Forms

CV-26 05 19 Low-Voltage Electrical Power Conductors and Cables

CV-26 05 26 Grounding and Bonding for Electrical Systems

CV-26 05 33 Raceways and Boxes for Electrical Systems

CV-26 24 16 Panelboards

CV-26 51 13 Interior Lighting Fixtures, Lamps and Ballasts

**RELATED WORK**

Section 01 91 01 or 01 91 02 – Commissioning Process

**REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

**SUBMITTALS**

Reference the General Conditions of the Contract for submittal requirements.

Reference Section 01 91 01 or 01 91 02 Commissioning Process for Construction Verification Checklist and Functional Performance Test submittal requirements.

**PART 2 – PRODUCTS**

(Not Used)

**PART 3 – EXECUTION**

**COMMISSIONING FORMS**

Commissioning forms are to be filled in as work progresses by the individuals responsible for installation and shall be completed for each installation phase.

Provide a description of the work completed since the last entry, the percentage of the total work completed for the system for that area and the step of installation or finalization.

Circle Yes or No for each commissioning form item. If the information requested for an item does not apply to the given stage of installation for the system, list it as "N/A". Explain all discrepancies, negative responses or N/A responses in the negative responses section.

1 Once the work is 100% complete and the responses to each item are complete and resolved for a  
2 given commissioning forms group, mark as complete, initial and date in the spaces provided.  
3  
4 Provide copies of the commissioning forms to the commissioning agent 2 days prior to  
5 construction progress meetings.  
6

7  
8 **END OF SECTION**  
9  
10  
11  
12  
13  
14  
15

## CV-26 05 19 – Low-Voltage Electrical Power Conductor and Cables

Equipment Identification/Tag: \_\_\_\_\_  
Location: \_\_\_\_\_

### A) CONDUCTOR AND CABLING PULLING CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)						
				1)	2)	3)	4)	5)	6)	7)
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:			DATE:			

### Question Details

- 1) Conductor and cabling sized to maintain less than a 3% voltage drop for rated length and ampacity of circuit.
- 2) Conductors and cabling coloring match specification requirements for given voltage, wire gauge, and leg of circuit.
- 3) Conduits swabbed to remove foreign material prior to pulling cables.
- 4) All cables pulled though conduit at the same time, with pulling lubricant used to ease pulling tensions.
- 5) Excess cable provided at each termination and splice point for purpose of multiple terminations or splices to be performed.
- 6) Emergency power conductors and cabling pulled in separate conduits from normal power systems.
- 7) Outdoor cables not to be terminated within 8 hours to be properly sealed and protected from moisture intrusion until termination.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

Construction Verification Checklist  
26 05 19 – Low-Voltage Electrical Power Conductors and Cables

**B) CONDUCTOR AND CABLE TERMINATIONS & SPLICES CHECKS**

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)								
				1)	2)	3)	4)	5)	6)	7)	8)	
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:				DATE:				

**Question Details**

- 1) Installed lugs match the pads on the equipment to which the cable will be mounted.
- 2) All lug terminations are connected per connection torque valve as recommended by the manufacturer.
- 3) Splices made only in accessible junction boxes.
- 4) All conductors and cables cleaned prior to termination.
- 5) All splices made so that the electrical resistance of the splice does not exceed the equivalent resistance of 2' of conductor.
- 6) Solderless spring type pressure connectors with insulating covers used for all wires splices and taps of conductors and cabling 10AWG and smaller.
- 7) Mechanical or compression connectors used for all wire splices and taps of conductors and cabling 8 AWG and larger.
- 8) Uninsulated conductors and connectors taped with electrical tape equivalent to 150% of the insulation value of the conductor.

**Negative Responses**

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

Construction Verification Checklist  
26 05 19 – Low-Voltage Electrical Power Conductors and Cables

**C) TESTING & FINALIZATION CHECKS**

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)				
				1)	2)	3)	4)	5)
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS: _____ DATE: _____				

**Question Details**

- 1) All exposed conductors and cabling has been visually inspected for physical damage and any damaged conductors and cabling has been replaced.
- 2) Conductors and cabling jacket and insulation are in good condition.
- 3) All cable terminations have been checked for proper tightness and clearances per specification and manufacturer recommendations and any adjustments necessary have been made.
- 4) For aluminum conductors and cabling all specified acceptance tests have been performed on all cables, terminations, and splices and are approved prior to energizing.
- 5) All splices and terminations are to be tagged within 2" to 4" of splice or termination and in accordance with specification requirements.

**Negative Responses**

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

## CV-26 05 26 – Grounding and Bonding for Electrical Systems

Equipment Identification/Tag: \_\_\_\_\_  
Location: \_\_\_\_\_

### A) GENERAL GROUNDING AND BONDING INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)									
				1)	2)	3)	4)	5)	6)	7)	8)	9)	
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:		DATE:							

### Question Details

- 1) Mechanical connections accessible for inspection and checking, with no insulation of connections.
- 2) Ground connection surfaces cleaned and all connections made permanent.
- 3) Grounds attached permanently before permanent building service is energized.
- 4) Grounding electrode conductors installed in PVC conduit or rigid galvanized steel conduit and bonded at both ends to the grounding electrode conductor with an approved grounding fitting.
- 5) Grounding electrode is correct size and length.
- 6) Grounded conductor run to each service disconnecting means and its enclosure.
- 7) Separate insulated equipment grounding conductor installed with phase conductors within each raceway.
- 8) All metallic systems (water, gas, sprinkler, etc.) and lightning protection system bonded to ground system.
- 9) System bonded within 5' from point of entry into building to at least two of the following: metal underground water pipe, metal frame of building, concrete encased electrodes, ground ring, (underground local systems such as storage tanks, conduit, or piping), ground rod installed 8' deep or at 45-degree angle and distanced a minimum of 6' apart., ground plate buried 2-1/2' deep.

Construction Verification Checklist  
26 05 26 – Grounding and Bonding for Electrical Systems

**Negative Responses**

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

**B) LOW VOLTAGE (<600V) GROUNDING AND BONDING INSTALLATION CHECKS**

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)						
				1)	2)	3)	4)	5)	6)	7)
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:			DATE:			

**Question Details**

- 1) Code sized copper grounding electrode conductor provided from secondary switchboard ground bus, each separately derived system neutral, secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes.
- 2) Bonding jumper provided around water meter.
- 3) Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor bonded in raceways and cables, receptacle ground connectors, and plumbing systems.
- 4) Separate insulated equipment grounding conductor provided within each raceway.
- 5) Ground wire provided from each device to the respective enclosure.
- 6) Communications system grounding conductor provided at point of service entrance and connected to building common grounding electrode system.
- 7) Telecommunications and audio visual systems installed with an isolated grounding system with only one ground point at the electrical service entrance for the building per specification requirements.

Construction Verification Checklist  
26 05 26 – Grounding and Bonding for Electrical Systems

Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		



CV-26 05 33 – Raceway and Boxes for Electrical Systems

Equipment Identification/Tag: \_\_\_\_\_  
Location: \_\_\_\_\_

A) CONDUIT & FITTINGS PRE-INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)		
				1)	2)	
			YES NO	YES NO		
			YES NO	YES NO		
			YES NO	YES NO		
			YES NO	YES NO		
<input type="checkbox"/> CHECKLIST GROUP COMPLETE						
				INITIALS:	DATE:	

Question Details

- 1) Conduit type and material in accordance with specification requirements for given application and location.
- 2) Conduit sufficiently sized to accommodate cabling and fill requirements of contract document.

Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

Construction Verification Checklist  
26 05 33 – Raceway and Boxes for Electrical Systems

**B) CONDUIT & FITTINGS INSTALLATION CHECKS**

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)										
				1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:			DATE:							

**Question Details**

- 1) Conduit support spacing complies with specification requirements.
- 2) All conduit supported independently of piping, ductwork, equipment, cable tray or other conduit.
- 3) Bends in conduit minimized with required bends conforming to specification requirements and no more than an equivalent of three 90 degree bends between boxes.
- 4) Moisture traps are avoided as much as possible. When unavoidable, a junction box is provided with drain fitting at conduit low point.
- 5) All equipment requiring maintenance is accessible.
- 6) Minimum 6" clearance between conduit and piping, and 12" clearance between conduit and heat sources such as flues, steam pipes, and heating appliances is provided.
- 7) No continuous conduit run exceeds 100' without a junction box.
- 8) Expansion-deflection joints installed where conduit crosses building expansion joints.
- 9) Where conduit passes between areas of differing temperatures, listed conduit seals are provided.
- 10) At end of work day suitable conduit caps or other approved seals provided for incomplete work to protect installed conduit against entrance of dirt and moisture.

**Negative Responses**

Group/Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES/NO		
					YES/NO		
					YES/NO		
					YES/NO		
					YES/NO		

Construction Verification Checklist  
26 05 33 – Raceway and Boxes for Electrical Systems

### C) RACEWAY & GUTTER INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)								
				1)	2)	3)	4)	5)	6)	7)	8)	
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS: _____				DATE: _____				

### Question Details

- 1) Raceway and gutter support spacing and methods comply with specification requirements.
- 2) All raceways supported independently of piping, ductwork, equipment, cable tray or other conduit.
- 3) Suitable insulating bushings and inserts provided at connections to outlets and corner fittings.
- 4) All equipment requiring maintenance is accessible.
- 5) Expansion-deflection joints installed where conduit crosses building expansion joints.
- 6) Oil tight gutters included gaskets at each joint.
- 7) Rain-tight gutters are installed in horizontal position only.
- 8) At end of work day suitable caps or other approved seals provided for incomplete work to protect installed raceways and gutters against entrance of dirt and moisture.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

Construction Verification Checklist  
26 05 33 – Raceway and Boxes for Electrical Systems

### D) JUNCTION, PULL AND OUTLET BOXES INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)									
				1)	2)	3)	4)	5)	6)	7)	8)	9)	
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:			DATE:						

### Question Details

- 1) Boxes provided in locations as per contract documents, Engineer's direction or as necessary for splicing and terminations.
- 2) Box type and material in accordance with specification requirements for given application and location.
- 3) No outlet box located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.
- 4) All boxes supported independently of conduit, piping, ductwork, equipment, or cable tray.
- 5) No outlet boxes installed back-to-back in walls, and minimum 6" separation between all boxes, except for installations in acoustic walls where a minimum 24" separation between boxes is provided.
- 6) All boxes are accessible, and where installation is inaccessible, 18" by 24" access door has been provided.
- 7) Mounting heights for outlet boxes corresponds with contract document requirements.
- 8) All recessed outlet boxes in finished areas are mounted to the correct depth to accommodate and be flush to final surface finish.
- 9) Knockout closures provided for unused openings.

### Negative Responses

Group/Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES/NO	Date Resolved	Resolution
					YES/NO		
					YES/NO		
					YES/NO		
					YES/NO		
					YES/NO		

Construction Verification Checklist  
26 05 33 – Raceway and Boxes for Electrical Systems

**E) FINALIZATION CHECKS**

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)											
				1)	2)	3)	4)	5)	6)	7)	8)	9)	10)		
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:						DATE:					

**Question Details**

- 1) All penetrations through fire rated wall assemblies have been sealed per specification requirements.
- 2) All penetrations through non-rated wall assemblies have been sealed per specification requirements for given space type.
- 3) Conduits that penetrate the building envelope are sealed to prevent intrusion of air and moisture and are accessible.
- 4) All conduit junction boxes are painted and tagged in accordance with specification requirements.
- 5) All splices and terminations are to be tagged within 2" to 4" of splice or termination and in accordance with specification requirements.
- 6) 1/8" nylon pull string provided in all empty conduits, except sleeves and nipples.
- 7) Grounding and bonding of conduits and raceways conform to specification requirements.

**Negative Responses**

Group/Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		



Construction Verification Checklist  
26 24 16 – Panelboards

## CV-26 24 16 – Panelboards

Equipment Identification/Tag: \_\_\_\_\_

Location: \_\_\_\_\_

Group/Item	Group/Task Description	Submitted	Delivered
<i>A</i>	<i>MODEL VERIFICATION</i>		
1	Manufacturer		
2	Model		
3	Catalog Number		
4	Voltage / Phase / Frequency (V / - /Hz)	/ /	/ /
5	Main Amps (A)		
6	Circuit Count		
7	kAIC rating (kA)		
<input type="checkbox"/> CHECKLIST GROUP COMPLETE		INITIALS: _____	DATE: _____

Group/Item	Group/Task Description	Response	
<i>B</i>	<i>PHYSICAL CHECKS</i>		
1	Unit is free from physical damage.	YES	NO
2	All components/accessories present.	YES	NO
3	Circuit breaker capacities documented.	YES	NO
4	Unit tags affixed.	YES	NO
5	Manufacturer's ratings readable/accurate.	YES	NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE		INITIALS: _____	DATE: _____

Group/Item	Group/Task Description	Response	
<i>C</i>	<i>INSTALLATION</i>		
1	Unit secured as required by manufacture, specifications, and seismic zone requirements.	YES	NO
2	Adequate clearance around unit for service per table NEC-110.26.	YES	NO
3	Top of tub set at 6' from finished floor unless specified otherwise in contract documents.	YES	NO
4	Conduit feeds are aligned with openings and accommodate seismic motion.	YES	NO
5	Unit is level, plumb, and square.	YES	NO
6	Unit labeled and is easy to see.	YES	NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE		INITIALS: _____	DATE: _____

Group/Item	Group/Task Description	Response	
<i>D</i>	<i>WIRING</i>		
1	Three spare ¾" empty conduits provided (recessed units ONLY).	YES	NO
2	Unit is adequately grounded to grounding lug for intended use.	YES	NO
3	Proper phasing has occurred in relationship to phase conductors.	YES	NO
4	All connections are terminated properly.	YES	NO
5	All electrical connections are tight.	YES	NO
6	All cables are permanently labeled relative to use.	YES	NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE		INITIALS: _____	DATE: _____

Group/Item	Group/Task Description	Response	
<i>E</i>	<i>STARTUP</i>		
1	All protective coverings have been removed.	YES	NO

Construction Verification Checklist  
26 24 16 – Panelboards

Group/Item	Group/Task Description	Response	
2	Unit has been cleaned of all debris and dirt on interior of unit.	YES	NO
3	Insulators and supports show no signs of damage or cracks.	YES	NO
4	Current transformers secured and wired per manufacturer instructions (metering applications ONLY).	YES	NO
5	All electronic circuit breaker settings have been adjusted to desired setting (if applicable).	YES	NO
6	Ground-fault-protection (GFP) trip and time delays have been adjusted to desired setting (if applicable).	YES	NO
7	All wiring connections verified for proper torques values and are acceptable.	YES	NO
8	Phase-to-phase, phase-to-ground, and neutral-to-ground, and dielectric tests have been accomplished and results are acceptable.	YES	NO
9	No hazards or adverse circumstances exist per continuity and high potential tests.	YES	NO
10	Insulation megger test accomplished and results acceptable.	YES	NO
11	Unit energized by authorized personnel.	YES	NO
12	All damage to unit finish is repaired.	YES	NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE		INITIALS: _____	DATE: _____
<i>F</i>	<i>TESTING &amp; FINALIZATION</i>		
1	Overcurrent protective devices have been manually exercised.	YES	NO
2	Solid state circuit breaker self-diagnostics completed.	YES	NO
3	Electronic circuit breaker trip unit tests completed.	YES	NO
4	Ground-fault-protection (GFP) system tested and certified.	YES	NO
5	Filler plates provided for all unused spaces.	YES	NO
6	As-built circuit index provided and attached to interior of unit door.	YES	NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE		INITIALS: _____	DATE: _____

### Negative Responses

Group/Item	Date Found	Found By	Reason for Negative Response	Resolved	Date Resolved	Resolution
				YES / NO		
				YES / NO		
				YES / NO		
				YES / NO		
				YES / NO		



## CV-26 51 13 – Interior Light Fixtures, Lamps and Ballasts

## A) INSTALLATION CHECKS

## Question Details

- DFD Project No.  
26 08 00 - 16

Construction Verification Checklist  
26 51 13 – Interior Light Fixtures, Lamps and Ballasts

- 9) All wall mounted fixtures and exit signs are mounted at heights specified in contract documents.
- 10) All fixtures are supported and installed in accordance with manufacturer and specification requirements.

Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

Construction Verification Checklist  
26 51 13 – Interior Light Fixtures, Lamps and Ballasts

**B) WIRING INSTALLATION CHECKS**

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)				
				1)	2)	3)	4)	5)
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS: _____ DATE: _____				

**Question Details**

- 1) Fixture and accessories grounded and bonded to branch circuit grounding conductor.
- 2) Maximum of 6' of flexible conduit provided for lay-in, recessed fixtures.
- 3) All electrical connections are tight.
- 4) All conductors are labeled per specification requirements.

**Negative Responses**

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

Construction Verification Checklist  
26 51 13 – Interior Light Fixtures, Lamps and Ballasts

### C) STARTUP & TESTING CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)			
				1)	2)	3)	4)
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:		DATE:	

### Question Details

- 1) Emergency indicating button/lamp visible and verified to be operational (if applicable).
- 2) Associated emergency ballast tested and operation verified (if applicable).
- 3) Occupancy sensor and associated fixture(s) tested and operation verified (if applicable).
- 4) Lighting control schedules programmed and operation verified for all associated fixtures (if applicable).

### Negative Responses

Group/Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

# Construction Verification Checklist

## D) FINALIZATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)											
				1)	2)	3)	4)	5)	6)	7)	8)	9)	10)		
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
☐ CHECKLIST GROUP COMPLETE				INITIALS:						DATE:					

## Question Details

- 1) Protective covering removed.
- 2) Lens, trim ring and other architectural accessories installed.
- 3) Recessed fixtures are flush to finished surface with no visible gaps.
- 4) Code-required hardware is installed to secure recessed grid-supported fixtures in place.
- 5) Recessed fixtures in fire rated assemblies have been sealed per manufacturer and specification requirements to maintain assembly rating.
- 6) Number and type of lamps specified for each fixture installed and operational.
- 7) Fluorescent lamps installed in fixtures with dimming ballasts have been burned in at 100% rated output for a minimum of 100 hours.
- 8) Fixture adjusted and aimed for specific task or effect per contract documents and/or Architect's directions.
- 9) All damages to fixture finish repaired.
- 10) Fixtures and lens are clean.

Construction Verification Checklist  
26 51 13 – Interior Light Fixtures, Lamps and Ballasts

Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

Functional Performance Test  
26 32 13.13 and 26 32 13.16 - Engine-Driven Generator Sets

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DIVISION 26 – ELECTRICAL

**SECTION 26 24 16  
PANELBOARDS**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes main, distribution and branch circuit panelboards. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Submittals
- Operation and Maintenance Data
- Spare Parts

**PART 2 - PRODUCTS**

- Branch Circuit Panelboards

**PART 3 - EXECUTION**

- Installation
- Field Quality Control
- Construction Verification Items
- Agency Training

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 - Commissioning Process.

Section 26 08 00 - Commissioning of Electrical.

Section 26 43 13 - Surge Protective Devices for Low-Voltage Electrical Power Circuits

**SUBMITTALS**

Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, and circuit breaker arrangement and sizes.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**SPARE PARTS**

Keys: Furnish 2 keys for each panelboard to Owner.

**PART 2 - PRODUCTS**

**BRANCH CIRCUIT PANELBOARDS**

Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.

The panelboard and overcurrent devices contained within shall be **fully-rated**.

Enclosure: Type 1, minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.

Provide surface cabinet front with concealed trim clamps, concealed hinge and flush cylinder lock all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

Provide metal directory holders with clear plastic covers.

1 Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on  
2 Drawings.  
3  
4 Provide ground bars in all panelboards. Phase, neutral and ground bar terminations can be dual  
5 rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of  
6 breakers.  
7  
8 Incoming conductors shall terminate at lug landing pads rated for the panelboard.  
9  
10 Provide compression type lugs to accommodate the conductor shown on drawings.  
11  
12 Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings and  
13 as required by short circuit/ coordination study.  
14  
15 Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL  
16 Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit  
17 breakers UL listed as Type HACR for air conditioning equipment branch circuits.  
18  
19 Do not use tandem circuit breakers.  
20  
21 Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any  
22 sort will be approved.  
23  
24 Provide a minimum of 10% spare circuit breakers in branch panelboards.  
25  
26 All of the panelboards provided under this section shall be by the same manufacturer.  
27  
28 All sub-feed panelboards installed side by side shall utilize same enclosure height.  
29

### 30 **PART 3 - EXECUTION**

#### 31 **INSTALLATION**

32 See section 26 05 29 for support requirements.

33 Install panelboards plumb with wall finishes.

34 Height: Branch panelboards: 6'-0" to top of panelboard.

35 Install a crimp type stud termination to stranded conductor when terminating on circuit breakers  
36 without a captive assembly rated for terminating stranded conductors.

37 Provide filler plates for unused spaces in panelboards.

38 See section 26 05 53 for identification requirements. Provide typed circuit directory for each  
39 branch circuit panelboard. Revise directory to reflect circuiting changes required to balance  
40 phase loads.

41 Stub three (3) empty ¾" conduits to accessible location above ceiling or below floor out of each  
42 recessed panelboard. Cap these conduits to prevent material from entering them.

#### 43 **FIELD QUALITY CONTROL**

44 If aluminum conductors size #1/0 and larger (per Section 26 05 19) are to be used as panelboard  
45 feeders, it is the responsibility of the contractor to provide panelboards with adequate wire  
46 bending space to accommodate the aluminum conductors and terminators to meet allowable  
47 code requirements. The Contractor shall circuit the panelboards as shown on the drawings.  
48 Measure steady state load currents at each panelboard feeder. Should the difference at any  
49 panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance  
50 the phase loads within 10 percent.

51 Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage,  
52 and grounding. Check proper installation and tightness of connections.  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63

1 **CONSTRUCTION VERIFICATION**  
2 Contractor is responsible for utilizing the construction verification checklists supplied under  
3 specification Section 26 08 00 in accordance with the procedures defined for construction  
4 verification in Section 01 91 01 or 01 91 02.  
5  
6 **AGENCY TRAINING**  
7 All training provided for agency shall comply with the format, general content requirements and  
8 submission guidelines specified under Section 01 91 01 or 01 91 02.  
9  
10  
11 **END OF SECTION**  
12

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DIVISION 26 – ELECTRICAL

**SECTION 26 27 26  
WIRING DEVICES**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes wall switches, receptacles, occupancy sensors, device plates and box covers, access floor boxes, photo cells and time clocks. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Submittals

Operation and Maintenance Data

**PART 2 - PRODUCTS**

Wall Switches

Receptacles

Occupancy Sensors

Wall Dimmers

Device Plates and Box Covers

Photo Cells

Time Clocks

**PART 3 - EXECUTION**

Installation

Field Quality Control

Occupancy Sensors

Adjusting

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02- Commissioning Process.

**SUBMITTALS**

Provide product data showing model numbers, configurations, finishes, dimensions, and manufacturer's instructions.

For occupancy sensor shop drawings, the manufacturer's actual layout of occupancy sensors and the wiring diagrams shall be provided.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**PART 2 - PRODUCTS**

**WALL SWITCHES**

**General:** Heavy duty use toggle switch, rated 20 amperes and 120/277 volts AC. Switches shall be UL20 Listed and meet Federal Specification WS-896. All switches shall be heavy duty Specification Grade.

Handle: made of nylon or high impact resistant material.

Color: Device color to be determined by Architect.

**Wall Switches for Lighting Circuits and Motor Loads Under 1/2 HP:** All switches shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with separate green ground screw. Switches shall be Cooper Arrow-Hart 1221\*, Hubbell 1221\*, Leviton 1221-S\*, Pass & Seymour CS20AC1-\*, or approved equal. (\* indicates color selection).

Color: Device color to be determined by Architect.

## **RECEPTACLES**

**General Requirements:** NEMA Type 5-20R, nylon or high impact resistant face. Receptacles shall be UL498 Listed and meet Federal Specification WC-596. All duplex receptacles shall be heavy duty Specification Grade, 20 amp rated.

Color: Device color to be determined by Architect.

Generally, all receptacles shall be duplex convenience type unless otherwise noted.

All receptacles designated as isolated ground shall have an isolated ground triangle imprint on the face of the receptacle.

All receptacles installed in bathrooms, kitchens, and within 6 feet of the outside edge of sinks shall be GFCI type.

All receptacles installed in outdoor locations, garages, rooftops, and in other damp or wet locations shall be GFCI type with a weather-resistant (WR) rating.

**Convenience and Straight-blade Receptacles:** All receptacles shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with a separate green ground screw. Receptacles shall be Cooper Arrow-Hart 5362\*, Hubbell 5362\*, Leviton 5362-S\*, Pass & Seymour PS5362-\*, or approved equal. (\* indicates color selection).

**GFCI Receptacles:** Duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class A. GFCI receptacles shall be Cooper Arrow-Hart VGF20\*, Hubbell GF20\*L, Leviton N7899-\*, Pass & Seymour 2095\*, or approved equal.

**GFCI Receptacles with a weather-resistant (WR) rating:** Weather-Resistant duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class-A. WR GFCI receptacles shall be Cooper Arrow-Hart WRVGF20\*, Hubbell GFR5362\*TR, Leviton WR899-\*, Pass & Seymour 2095TRWR\*, or approved equal.

Locking-Blade Receptacles: As indicated on drawings.

Specific-use Receptacle Configuration: As indicated on drawings.

## **OCCUPANCY SENSORS**

### **General**

Refer to the Drawing Schedules for specific project requirements for occupancy sensors.

All occupancy sensors shall be hardwired type; battery type shall not be permitted.

Sensors shall use either passive infrared, or if dual technology, passive infrared and passive acoustic sensing or passive infrared and ultrasonic sensing for detecting room occupancy.

Sensitivity shall be user adjustable or self-adjusting type.

The delay timer shall be adjusted within a range of 6 to 30 minutes by the contractor in the field. The sensor shall have a test mode for performance testing.

The test LED shall indicate motion.

Line voltage sensors are acceptable, especially in exposed ceiling areas where all wiring shall be installed in conduit, including low voltage cabling if power packs are used. Provide power pack as required for low voltage sensors.

See drawings for actual types of sensors.

Occupancy sensors and power packs shall have five year warranties.

#### **Wall Mounted (Wall Switch Type)**

The unit shall fit in/on a standard single gang switch box.

Rated capacity: 600 watts minimum at 120 volts, 60 Hz; 1000 watts minimum at 277 volts, 60 Hz.  
The sensor shall have two switches where dual-level lighting is required. The switch shall have manual override for positive OFF and automatic ON.

The area of coverage shall be approximately 180 degrees by 35-40 feet.

#### **Ceiling Mounted**

The unit shall fit in/on a standard octagon box. All ceiling mounted sensors shall be installed to a box with ring and box support.

The coverage area shall be 360 degrees by approximately 15 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas.

#### **Ceiling/Corner Mounted**

The unit shall fit in/on a standard octagon box. All ceiling mounted sensors shall be installed to a box with ring and box support.

The coverage area shall be 90 degrees or greater by approximately 40 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas.

#### **Power Packs**

Provide power packs as required for low voltage sensors. Rated capacity shall be 20 amps at 120 or 277 volts for fluorescent lamps.

The unit shall fit on a standard octagon box. All power packs shall be installed onto a supported box.

Low voltage cabling shall be plenum rated or installed in conduit in plenum-rated areas.

#### **Auxiliary Contacts for HVAC Interlock**

Provide auxiliary dry contacts for HVAC BAS interlock when required. Refer to the "Occ Sensor Interlock" column in the Air Terminal Schedule(s) on the HVAC drawings. When required, provide auxiliary contacts regardless if the occupancy sensors are line or low voltage.

The occupancy sensors and auxiliary contacts shall be wired such that the sensor still detects occupancy and controls the auxiliary contacts regardless if the light switch(es) are in the OFF position (e.g. the occupant has turned the lights OFF because there is enough daylight, but the occupant is still occupying the space, and the occupancy sensor senses the occupant and closes the auxiliary contacts for BAS input).

The BAS wiring to the auxiliary contacts shall be by the Division 23 contractor.

All occupancy sensors shall be hardwired type; battery type shall not be permitted.

#### **WALL DIMMERS**

Wall Dimmers: linear slide semiconductor type.

Coordinate LED dimmers with approved types as recommended by LED fixtures manufacturer.

Rating: 600 Watts minimum, larger size to accommodate load shown on Contract Drawings.

Color: Device color to be determined by Architect.

#### **DEVICE PLATES AND BOX COVERS**

**Decorative Cover Plate:** Smooth nylon.

Color: Device color to be determined by Architect.

**Weatherproof Cover Plate:** Gasketed metal with hinged "in-use" device covers, powder coat painted. Non-metallic covers are not allowed. All receptacles installed in wet locations shall have an enclosure that is weatherproof whether or not the attachment plug is inserted.

**Damp Location Cover Plate:** Gasketed metal with hinged device covers, powder coat painted. Non-metallic covers are not allowed. All receptacles installed outdoors in a location protected from the weather or in other damp locations shall have an enclosure that is weatherproof when the receptacle is covered (attachment plug not inserted and receptacle covers closed).

**Surface Cover Plate:** Raised galvanized steel.

## **PHOTO CELLS**

The controller shall be rated 2000 watts tungsten at 120, 240 or 277 volts. The cell shall be cadmium sulfide, 1" diameter.

The enclosure shall be die cast zinc, gasketed for maximum weather proofing.

The enclosure shall include the positioning lug on the top of the enclosure.

The unit shall have a delay of up to two minutes to prevent false switching. ON/Off adjustment shall be done by moving a light selector with a range from 2 to 50 foot-candles.

Mounting shall be for a 1/2" conduit nipple.

The unit shall have a 5 year warranty.

The contacts shall be SPST normally closed.

The operational temperature range shall be -40 to 140 degrees F (-40 to +60 degrees C).

## **TIME CLOCKS**

Unit shall be a multi-purpose, 7-day, 365-day advance single and skip a day, combination 2-channel electronic time clock with a SPDT switching configuration and astronomic dial.

The contacts shall be rated 10 amp resistive at 120/250 VAC, 7.5 amps inductive at 120/250 VAC, 5 amps inductive at 30 VDC and up to 1/2 HP at 250 VAC. The unit shall be rate for 30 VDC, 120 VAC, 250 VAC and 277 VAC.

The controller shall be capable of programming in the AM/PM or 24 hour format by jumper selection, in one minute resolution, using 2 buttons only for all basic settings.

Display shall be LED type.

The unit shall have 365 day and or holiday selection capabilities, with 16 single date and 5 holiday selection options and user selectable daylight savings/standard time functions.

The unit shall have 72 hour memory backup with rechargeable battery and charger.

The unit shall be capable of manual override, ON and OFF to the next scheduled event, using 1 button for each channel.

The enclosure shall be rated for indoor or outdoor installation.

## **PART 3 - EXECUTION**

### **INSTALLATION**

See plans for device mounting heights.



1  
2 Install wall switches with OFF position down.  
3  
4 Wall dimmers: de-rate ganged dimmers as instructed by manufacturer; do not use common  
5 neutral.  
6  
7 Install convenience receptacles with grounding pole on bottom.  
8  
9 Install box for information outlet at the same height as adjacent convenience receptacles. Locate  
10 boxes for information outlet as close as practical to duplex power outlet, approximately 2-inches  
11 apart.  
12  
13 Install box for telephone jack for wall telephone at 46-inches to center above finished floor.  
14  
15 Install specific-use receptacles at heights shown on Contract Drawings.  
16 Install decorative plates on switch, receptacle, and blank outlets in finished areas.  
17  
18 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above  
19 accessible ceilings, and on surface-mounted outlets.  
20  
21 Install devices and wall plates flush and level.  
22  
23 Receptacles shall have a bonding conductor from grounding terminal to the metal conduit system.  
24 Self-grounding receptacles using mounting screws as bonding means are not approved.  
25  
26 Drill opening for poke-through fitting installation in accordance with manufacturer's instructions.  
27  
28 **FIELD QUALITY CONTROL**  
29 Inspect each wiring device for defects.  
30  
31 Operate each wall switch and sensor with circuit energized, and verify proper operation.  
32  
33 Verify that each receptacle device is energized.  
34  
35 Test each receptacle device for proper polarity.  
36  
37 Test each GFCI receptacle device for proper operation.  
38  
39 The user agency and DFD personnel reserve the right to be present at all tests.  
40  
41 **OCCUPANCY SENSORS**  
42 Power packs used in return air plenum ceiling areas shall be installed in an approved enclosure  
43 or UL listed for return air plenum.  
44  
45 Provide a minimum of 4' of coiled cable for ceiling-mounted sensors.  
46  
47 Occupancy sensors shall be installed at locations indicated on the manufacturer's submittal  
48 layout drawings. Sensors shall be located to prevent false "ON" tripping of the lights.  
49  
50 Sensitivity Test: After the sensor has been energized for at least 15 minutes, walk to the middle of  
51 the room (if conference room) or sit at the normal desk position (if an office). Make no motion for  
52 20 seconds. Move one arm up and down slowly. The test LED should blink.  
53  
54 Time Delay Test: Set the time delay for 10 minutes. Walk into the room to activate the sensor  
55 then leave room. Sensor must turn lights off at approximately 10 minutes. Walk into the room  
56 again to reactivate the lights. Lights should activate within 1 second.  
57  
58 For lights on emergency power *without* an emergency lighting control unit (ELCU), use the  
59 *emergency* circuit to energize the occupancy sensor's power pack. Route the emergency circuit

1 through the occupancy sensor's power pack relay to the light fixtures. Route any non-emergency  
2 circuits controlled by the same occupancy sensor through separate auxiliary relay packs.

3  
4 For lights on emergency power *with* an ELCU, route the *normal* power through the switches and  
5 occupancy sensor relay to the ELCU, then to the normal power lighting fixtures. Connect the  
6 emergency circuit to the ELCU's emergency power terminals, then to the emergency lighting  
7 fixtures. The ELCU will control the emergency lighting along with the normal lighting controls, but  
8 will turn the emergency lights ON in a power outage, regardless of the position of the switches or  
9 relays.

#### 10 11 **ADJUSTING**

12 Adjust devices and wall plates to be flush and level.

13  
14 Mark all conductors with the panel and circuit number serving the device with a machine  
15 generated label, at the device, and on the back of the device cover.

16  
17  
18 **END OF SECTION**  
19  
20

DIVISION 26 – ELECTRICAL

**SECTION 26 27 28  
DISCONNECT SWITCHES**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes disconnect switches, fuses and enclosures. Included are the following topics:

**PART 1 - GENERAL**

Scope

Related Work

Submittals

Operation and Maintenance Data

General

**PART 2 - PRODUCTS**

Disconnect Switches

Fuses

**PART 3 - EXECUTION**

Installation

Construction Verification Items

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 - Commissioning Process

Section 26 08 00 - Commissioning of Electrical

Section 26 29 00- Low voltage Controllers

**SUBMITTALS**

Include outline drawings with dimensions, and equipment ratings for voltage, ampacity, horsepower, and short circuit.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**GENERAL**

Provide disconnect switches for loads required by code. Review HVAC and Plumbing specifications to determine what equipment is furnished with disconnect switches. Install disconnect switches whether furnished under this contract or not. It is the Electrical Contractors responsibility to determine the need for a disconnect switch for each load. The contractors shall include in their bid the code required disconnect switches whether indicated on the drawings or not.

**PART 2 - PRODUCTS**

**DISCONNECT SWITCHES**

Fusible Switch Assemblies (use only when overcurrent protection is required): NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: designed to accommodate Class R, Class J or Class CC (motors) cartridge type fuses.

1 Nonfusible Switch Assemblies: NEMA Type Heavy Duty; quick-make, quick-break, load  
2 interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening  
3 front cover with switch in ON position. Handle lockable in OFF position.  
4

5 **Enclosure:**

6 Indoor: NEMA 1 code gauge steel with rust inhibiting primer and baked enamel finish  
7 Outdoors: NEMA 3R code gauge zinc coated steel with baked enamel finish or NEMA  
8 4 when indicated on drawings.  
9

10 Provide manufacturer's equipment ground kit in all disconnect switches.  
11

12 In applications where the switch serves as the service entrance disconnect, provide service  
13 ground kit, label as service disconnect and provide UL listing for service disconnect.  
14

15 **FUSES**

16 Fuses 600 Amperes and Less: Dual element, time delay, 600 volt, UL Class RK 1, Interrupting  
17 Rating: 200,000 rms amperes.  
18

19 Fuses 30 Amperes and less: Time-Delay, 600 volt, UL Class CC. Interrupting rating: 200,000 rms  
20 amperes.  
21

22 Provide three (3) spares of each size and type fuse. Provide cabinet/enclosure for spare fuses  
23 sized to accommodate all required spare fuses for entire facility. Locate cabinet in main electrical  
24 room.  
25

26  
27 **PART 3 - EXECUTION**  
28

29 **INSTALLATION**

30 Install disconnect switches where indicated on Drawings or required by NEC.  
31

32 Provide identification as specified in Section 26 05 53.  
33

34 Provide label on inside of disconnect cover identifying the type and size of fuse to be utilized.  
35

36 **CONSTRUCTION VERIFICATION**

37 Contractor is responsible for utilizing the construction verification checklists supplied under  
38 specification Section 26 08 00 in accordance with the procedures defined for construction  
39 verification in Section 01 91 01 or 01 91 02.  
40

41 **END OF SECTION**

DIVISION 26 - ELECTRICAL

**SECTION 26 29 00**  
**LOW-VOLTAGE CONTROLLERS**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes manual motor starters, magnetic motor starters, combination magnetic motor starters and motor control centers. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Coordination With Other Trades
- References
- Submittals
- Operation and Maintenance Data
- Delivery, Storage, and Handling
- Spare Parts

**PART 2 - PRODUCTS**

- Manual Motor Starters
- Magnetic Motor Starters
- Controller Overcurrent Protection and Disconnecting Means
- Fuses

**PART 3 - EXECUTION**

- Installation
- Construction Verification Items

**RELATED WORK**

Applicable provisions of Division 1 shall govern work under this Section.

Section 01 91 01 or 10 91 01- Commissioning Process  
Section 26 05 29 - Hangers and Supports for Electrical Systems.  
Section 26 08 00 - Commissioning of Electrical

**COORDINATION WITH OTHER TRADES**

Motors: In general, all electric motors required for this installation will be supplied with equipment, apparatus and/or appliances covered under other sections of the specifications.

For the sake of consistency and conformity of manufacturer, design and construction, all motors shall conform to the following description unless otherwise noted or required.

- Motors 1/3 HP and smaller shall be wound for operation on single phase, 60 Hz. service unless otherwise noted.
- Motors 1/2 HP and above shall be wound for operation on 3 phase, 60 Hz service unless otherwise noted.
- Refer to drawings in each case in order to verify voltage characteristics required.

**Equipment:**

All building utility motors such as fans, pumps, overhead doors, etc., together with certain "controlling equipment" for same, except motor starters and related apparatus, will be furnished under other sections of the specifications and delivered to the building site unless specifically noted otherwise. The above mentioned "controlling equipment" pertains to electrical thermostats, electro-pneumatic and pneumatic-electric and detection devices, or any other device not purely electrically operating in nature.

The starters for these motors shall be furnished and installed by the Electrical Trade unless noted otherwise. (See Motor Schedule on Drawings.)

The Electrical Trade shall set and connect all specified starting equipment, install all power conduits and wiring and shall furnish and make all connections from starting equipment to motors as required to leave the apparatus in running condition.

#### Wiring Connections:

Furnish branch circuits for all motors to the starting equipment and then to the motors, complete with all control wiring for automatic and remote control where required or noted. Conduits to motors shall terminate in the conduit fittings on the motors, the final connection being made with flexible, PVC-coated metal conduit.

Provide all necessary labor and material to completely connect all electrical motors and controls (where required) in connection with the building utility equipment, including fans, pumps, overhead door operators, etc.

All conduits and wiring required for control work from the holding coil circuit of the starter, including the furnishing and installation of control devices such as auxiliary contacts, control relays, time delay relays, pilot lights, selector switches, alternators, etc., shall be provided and installed by other trades unless otherwise indicated.

#### Power Branch Circuits:

Wire sizes for branch circuits not specifically called for on drawings or in specifications shall be based on 125 percent of the full load current of the motor unless the voltage drop of motor branch circuits exceeds 1-1/2 percent from the distribution panel to the motor; in which case, voltage drop shall govern wire sizes. A power factor of 80 percent shall be used for motors in such calculations.

### REFERENCES

ANSI/NEMA ICS 6 - Industrial Control and Systems: Enclosures.

ANSI/UL 198E - Class R Fuses.

ANSI/UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses.

NEMA AB 1 - Molded-case Circuit Breakers, Molded Case Switches, and Circuit-breaker Enclosures.

NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts.

NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches.

NEMA PB 1 - Panelboards.

NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

### SUBMITTALS

Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices.

### OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

### DELIVERY, STORAGE, AND HANDLING

Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

1 Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the  
2 purpose. Handle carefully to avoid damage to motor control center components, enclosure, and  
3 finish.

#### 4 **SPARE PARTS**

5 Keys: Furnish two (2) each to Owner.

6 *Provide three (3) spares of each size and type fuse used. Provide enclosure for spare fuses.*

7  
8 Fuse Pullers: Furnish one fuse puller to Owner.

### 9 **PART 2 - PRODUCTS**

#### 10 **MANUAL MOTOR STARTERS**

11 Manual Motor Starter: NEMA ICS 2; size as shown on Drawings. AC general-purpose Class A  
12 manually operated full-voltage controller for induction motors rated in horsepower, with overload  
13 protection, red pilot light and toggle operator.

14 Enclosure: NEMA Type 1 or as indicated on the drawings.]

15 Provide manufacturer's equipment ground kit in all starter enclosures.

#### 16 **MAGNETIC MOTOR STARTERS**

17 Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for  
18 induction motors rated in horsepower; size 0 minimum.

19 Full Voltage Starting: Non-reversing type.

20 Size: NEMA ICS 2; size as shown on Drawings, size 0 minimum.

21 Coil Operating Voltage: 120 volts, 60 Hz.

22 Overload Protection: The overload shall be solid-state, self-powered, provide phase loss and  
23 phase unbalance protection, have a permanent tamper guard, and be ambient insensitive. The  
24 overload shall have a mechanical test function.

25 Enclosure: NEMA Type 1, or as indicated on the drawings.

26 Provide manufacturer's equipment ground kit in all starter enclosures.

27 Auxiliary Contacts: NEMA ICS 2, two (2) field convertible contacts in addition to seal-in contact.

28 Selector Switches: NEMA ICS 2, HAND-OFF-AUTO in front cover.

29 Indicating Lights: NEMA ICS 2; red "RUN" LED Push-to-test type in front cover.

30 Control Power Transformers: Each magnetic starter shall have a fused primary and a fused  
31 120Vsecondary control transformer, sized for the load, 50 VA minimum. Additionally, the X2  
32 terminal of the control transformer shall be grounded.

33 Combination Motor Starters: Combine motor starters with [motor circuit protector] [fusible switch]  
34 disconnect in common enclosure.

#### 35 **CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTING MEANS**

36 Motor Circuit Protector: NEMA AB 1; circuit breakers with integral instantaneous magnetic trip in  
37 each pole.

1 Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife  
2 switch with externally operable handle. Provide interlock to prevent opening front cover with  
3 switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate  
4 Class J fuses.

## 6 **FUSES**

7 Fuses 600 Amperes and Less: Dual element, time delay, 600 volt, UL Class RK 5.  
8 Interrupting Rating: 200,000 rms amperes.

## 11 **PART 3 - EXECUTION**

### 13 **INSTALLATION**

14 Install motor control equipment in accordance with manufacturer's instructions.

16 Set overload protection in motor starters to match installed motor characteristics.

18 Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor  
19 served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase  
20 rating.

### 22 **CONSTRUCTION VERIFICATION**

23 Contractor is responsible for utilizing the construction verification checklists supplied under  
24 specification Section 26 08 00 in accordance with the procedures defined for construction  
25 verification in Section 01 91 01 or 01 91 02.

27 **END OF SECTION**  
28



DIVISION 26 – ELECTRICAL

**SECTION 26 36 00  
TRANSFER SWITCHES**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes transfer switches (less than 600V) for standby generator systems. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Regulatory and Standards Requirements

**PART 2 - PRODUCTS**

- Manual Transfer Switch
- Ratings
- Enclosure
- Accessories

**PART 3 - EXECUTION**

- Examination
- Installation
- Construction Verification Items
- Agency Training

**RELATED WORK**

Applicable provisions of Division 1 govern work under this section.

- Section 01 91 01 or 01 91 02 - Commissioning Process
- Section 26 05 26 - Grounding and Bonding for Electrical Systems
- Section 26 05 53 - Identification for Electrical Systems
- Section 26 08 00 - Commissioning of Electrical.

**REFERENCE STANDARDS**

The following references shall apply to the installation of equipment under this section.

- UL 1008- Standard for Transfer Switch Equipment
- Wisconsin Administrative Code SPS 316 Edition
- IEEE Standard 446- IEEE Recommended Practice for Emergency And Standby Power Systems.

**QUALITY ASSURANCE**

Manufacturer: Company specializing in automatic transfer equipment with five years documented experience.

**SUBMITTALS**

Submit product data under provisions of Division 1 and Section 26 05 00.

Submit product data showing overall dimensions, electrical connections, electrical ratings, withstand current rating (WCR's), all specified accessories, interlock methods, and environmental requirements.

Provide a UL test report showing compliance with UL 1008 for the ratings and conditions required by this installation.

Submit manufacturer's installation instructions.

## **OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

Instructions for operating equipment under test and emergency conditions.

## **PART 2 - PRODUCTS**

### **MANUAL TRANSFER SWITCH**

Description: NEMA KSI, UL 98, Article 702 NEC. Manual transfer switch suitable for use as service equipment without fuse holders. Double throw safety switch with NEMA 3R enclosure and padlocking cover and handle. Switch shall be suitable for service equipment per UL and load make/break rated with overlap assembly.

Fuses 300 Amperes, dual element, time delay, 600 volt, UL Class T. Interrupting Rating: 100,000 rms amperes.

Copper service ground bar and grounded neutral lugs.

Configuration: The transfer switch shall be manually-operated. The switch shall be rated for continuous duty.

The switch shall be suitable for use with any standby power source.

### **RATINGS**

Ratings: NEMA ICS 2; as follows:

Voltage: 120/240 volts, single phase, three wire, 60 Hz.

Switched Poles: 3.

Continuous Rating: 200 amperes

Fault Current Rating with Fuses: 100,000 rms symmetrical amperes.

### **ENCLOSURE**

Enclosure: NEMA Type 3R.

Lockable cover.

### **ACCESSORIES**

Manual Operator: Provide manual operator to allow switch to be operated under no-load conditions from behind a barriered partition or with the door closed.

An equipment ground bar shall be provided in each switch enclosure.

Two and three-pole transfer switches shall contain an overlapping neutral contact or a fully-rated switched neutral pole.

Two and three-pole transfer switches shall contain a fully rated solid neutral lug assembly.

## **PART 3 - EXECUTION**

### **EXAMINATION**

Verify that surfaces are ready to receive work.

Verify field measurements are as shown on Drawings.

1  
2 Verify that required utilities are available, in proper location, and ready for use.  
3  
4 Beginning of installation means acceptance of existing conditions.  
5  
6 **INSTALLATION**  
7 Install in accordance with manufacturer's instructions.  
8  
9 Coordinate installation with local Utility service requirements as a main service entry switch.  
10  
11 **CONSTRUCTION VERIFICATION**  
12 Contractor is responsible for utilizing the construction verification checklists supplied under  
13 specification Section 26 08 00 in accordance with the procedures defined for construction  
14 verification in Section 01 91 01 or 01 91 02.  
15  
16 **AGENCY TRAINING**  
17 All training provided for agency shall comply with the format, general content requirements and  
18 submission guidelines specified under Section 01 91 01 01 91 02.  
19  
20 **END OF SECTION**  
21

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DIVISION 26 – ELECTRICAL

**SECTION 26 43 13**  
**SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes Surge Protective Devices (SPD) as indicated on the project drawings and electrical diagrams. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference Standards
- Quality Assurance
- Warranty
- Submittals
- Operation and Maintenance Data

**PART 2 - PRODUCTS**

- Surge Protective Devices

**PART 3 - EXECUTION**

- Installation
- Construction Verification Items
- Agency Training

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 26 08 00 - Commissioning of Electrical.

**REFERENCE STANDARDS**

UL 1449, Third Edition – Standard For Safety For Surge Protective Devices.

ANSI/IEEE C62.41.1 Guide on the Surge Environment in Low-Voltage AC Power Circuits.

ANSI/IEEE C62.41.2 Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

ANSI/IEEE C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.

IEEE C62.62 Standard Test Specification for Surge Protective Devices For Low-Voltage AC Power Circuits.

NFPA 70, NEC Article 285

**QUALITY ASSURANCE**

The manufacturer shall have been in the Surge Protective Device industry for a minimum of 5 years.

**WARRANTY**

The manufacturer shall provide a minimum 5 year warranty from the date of shipment of the SPD.

**SUBMITTALS**

Include all SPD data necessary to show device is in compliance with all product specifications.

Include product data sheets showing the device performance, dimensions, weight, connections, and mounting requirements, along with installation instructions.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

## **PART 2 - PRODUCTS**

### **SURGE PROTECTIVE DEVICES**

The SPD shall be Listed in accordance with UL 1449, Third Edition. The product and ratings shall be included in the database of the UL.com web site.

The surge protective device (SPD) shall be designated a location Type 1 or Type 2 device intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch panel.

The SPD shall be connected in parallel with the facility's electrical system.

The SPD shall be made up of metal oxide varistors (MOV's), or a combination of MOV's with selenium cells or silicon avalanche diodes, ensuring that all of the performance requirements are met. Gas tubes shall not be used.

The entire SPD shall be enclosed in a metal or ABS enclosure, NEMA rated for the location. SPDs at main service equipment shall be mounted outside the switchboard or panelboard (not integral to, or installed within the switchboard or panelboard). SPDs for branch panelboard (2<sup>nd</sup> tier) locations may be mounted outside of, or integral to, the branch panelboard.

The SPD shall have a maximum continuous operating voltage (MCOV) rating not less than 115% of nominal voltage of the system it is protecting.

#### **Protection Modes:**

The SPD shall have line to neutral (L-N), line to ground (L-G), line to line (L-L) and neutral to ground (N-G) protection modes for three-phase grounded wye configured systems. For a three-phase delta configured system, the device shall have line to line (L-L) and line to ground (L-G) protection modes.

#### **Voltage Protection Rating (VPR):**

The UL 1449 Voltage Protection Rating (VPR) for the device shall not exceed the following:

208Y/120 volt applications: 900V L-N, L-G, N-G; 1200V L-L

#### **Nominal Discharge Current (In):**

The UL 1449 Nominal Discharge Current Rating (In) shall not be less than the following:

20kA for service entrance, switchboard, and main distribution panel locations  
10kA for branch panelboard (2<sup>nd</sup> tier) locations

#### **Short Circuit Current Rating (SCCR):**

The SPD shall have a UL 1449 Short Circuit Current Rating (SCCR) of not less than 200kA.

#### **Surge Current Rating:**

The single-pulse (8 X 20 microsecond waveform as specified in ANSI/IEEE Standard C62.41) surge current capacity shall not be less than the following:

100kA per mode (200kA per phase) for service entrance, switchboard, and main distribution panel locations  
50kA per mode (100kA per phase) for branch panelboard (2<sup>nd</sup> tier) locations

Each SPD shall include externally-mounted LED visual status indicators that indicate the on-line status of the unit, for each phase.

At service entrance, switchboard, and main distribution panel locations each SPD shall include the following features:

- audible diagnostic monitoring by way of an audible alarm function
- one set of NO/NC dry contacts for alarm conditions

### **PART 3 - EXECUTION**

#### **INSTALLATION**

Install SPD units in accordance with manufacturer's written instructions, applicable requirements of NEC and NEMA standards, and recognized industry practices.

The SPD units shall be installed at the locations shown on the drawings, or as indicated in the one-line diagram. They shall be parallel-connected to, and located adjacent to the switchboard or panelboard being protected. Locate as close as practical to the bus, keeping lead length as short as possible (less than 3 feet preferred to ensure optimum performance).

SPDs shall be connected through a multi-pole circuit breaker or fused disconnect switch, not into main lugs. Circuit breaker or fused disconnect switch shall be 60A for main service device, 30A for branch panelboard device or as recommended by the manufacturer.

Use schedule 40 PVC conduit or metallic conduit between the SPD and the switchboard or panelboard as recommended by the manufacturer. Avoid sharp bends, excess length, and splices in the wires. Where possible, use a close-nippled connection with wires going directly to a circuit breaker within the switchboard or panelboard.

Setup and test per the manufacturer's recommendations.

#### **CONSTRUCTION VERIFICATION**

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

#### **AGENCY TRAINING**

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

**END OF SECTION**

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DIVISION 26 – ELECTRICAL

**SECTION 26 51 13**  
**INTERIOR LIGHTING FIXTURES, LAMPS, AND BALLASTS**

*BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes interior luminaires and accessories, exit signs, lamps, and ballasts. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference Standards
- Definitions
- Submittals
- Operation and Maintenance Data
- Extra Material

**PART 2 - PRODUCTS**

- Interior Luminaires and Accessories
- Lamps
- LED Luminaires
- Fluorescent Ballasts
- Step-Dimming Ballasts (Fluorescent)

**PART 3 - EXECUTION**

- Installation
- Adjusting and Cleaning
- Interface with Other Products
- Field Quality Control
- All Fixture Connections Including Master-Slave
- Construction Verification
- Agency Training

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 - Commissioning Process.

Section 26 08 00 - Commissioning of Electrical

Section 26 27 26 - Wiring Devices

**REFERENCE STANDARDS**

RoHS - Restriction of Hazardous Substances. Council of the European Union (EC) Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

LM-79-08 (or latest) - IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.

LM-80-08 (or latest) - IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.

TM-21-11 (or latest) - IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.

NEMA SSL 1-2010 (or latest) - Electronic Drivers for LED Devices, Arrays, or Systems.

**DEFINITIONS**

Driver - the power supply used to power LED fixtures, modules, or arrays.

L70, L<sub>70</sub>, or L<sub>70%</sub> - The reported life of an LED component or system to reach 70% lumen maintenance, or 70% of the LED's original light output. This test is being developed by the IES and is currently described by TM-21-11.

LED's - Broadly defined as complete light fixture with light emitting diode (LED) packages, modules, light bars or arrays, complete with driver.

LED luminaire failure - Negligible light output from more than 10 percent of the LED's constitutes luminaire failure.

## **SUBMITTALS**

Include outline drawings, lamp and ballast data, support points, weights, accessory information and performance data for each luminaire type.

For each luminaire type, submit luminaire information including catalog cuts with highlighted catalog numbers and required accessories:

- Luminaire:
  - Manufacturer and catalog number.
  - Type (identification) as indicated on the plans and schedule.
- Ballast:
  - Manufacturer and catalog number.
  - Type (Programmed Start, etc.), Ballast Factor, THD, etc.
  - Quantity per fixture.
- Lamps:
  - Manufacturer, catalog number, and wattage
  - Quantity per fixture

## **OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

## **EXTRA MATERIAL**

Provide three (3) percent of each lamp type, but not less than one (1) of each type. This includes LED modules, light bars, or arrays.

Provide one (1) of each type of LED module, light bar, or array (if applicable). If the LED's are integrated into the fixture and are not separate components, then extra LED's are not required.

Provide one (1) ballast of each type. This includes LED drivers.

## **PART 2 - PRODUCTS**

### **INTERIOR LUMINAIRES AND ACCESSORIES**

See the Lighting Fixture Schedule on the drawings, for type of fixtures and catalog numbers. Catalog numbers are shown on the drawings for quality and performance requirements only. Fixtures manufactured by others are equally acceptable provided they meet or exceed the performance of the indicated fixtures, and meet the intent of the design.

Luminaire shall be certified by a Nationally Recognized Testing Laboratory (UL, ETL, or IEC).

Provide lighting fixtures with quick-connect disconnecting means, similar to Thomas & Betts Sta-Kon.

Fluorescent T8 lamps and ballasts shall be listed on CEE high-performance qualifying product list and approved by Focus-On-Energy.

## **LAMPS**

General Use Incandescent Lamps and Incandescent Reflector Lamps are prohibited. Use LED or compact fluorescent retrofit lamps in lieu of incandescent or halogen for specialty fixtures. LED retrofit lamps shall be:

- Rated for the voltage of the incandescent lamp they are replacing.
- Dimmable where required as indicated on the plans.
- Rated for the fixture in which they are being installed. Verify whether the fixture is enclosed and whether the retrofit lamp is rated for enclosed fixtures and the temperatures that will be encountered.
- Lamps shall provide delivered footcandles equal to or greater than the footcandles provided by an equivalent incandescent lamp.
- Lamps shall have an average rated life of 25,000 hours, minimum.
- Lamp color temperature shall be nearly equal to the incandescent lamp it is replacing.

Four Foot Fluorescent Lamps: High Performance T8 Lamps:

- Minimum 3000 initial lumens and minimum of 2820 mean lumens.
- Minimum 30,000 hour rated life at three-hour starts using programmed-start ballasts.
- Color Rendering Index (CRI) of 80 or higher.
- 5000°K color temperature.
- Lamps shall be suitable for use with instant start ballasts and occupancy sensors.
- Lamps shall meet Toxicity Characteristic Leaching Procedure (TCLP) requirements for low mercury as defined by the EPA.
- Mean system efficacy equal to 88 MLPW minimum using programmed-start ballasts.

Acceptable lamp manufacturers and catalog numbers are (or equal):

GE - F32T8/XL/SPX50/HL/ECO  
OSRAM/SYLVANIA - F032/850/XPS/ECO3  
PHILIPS - F32T8/ADV85/ALTO  
STANDARD PRODUCTS - F32T8/850/XL31

Manufacturer names and catalog numbers are used to develop quality and performance requirements only. Lamps manufactured by others will be accepted provided they meet or exceed the specifications.

All lamps shall be new.

## LED LUMINAIRES

- LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
  - Minimum Light Output.
  - Zonal Lumen Requirements.
  - Minimum Luminaire Efficacy.
  - Minimum CRI.
  - L70 Lumen Maintenance.
  - Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.

*Additional requirements:*

- Color Temperature of 3000K-5000K for interior fixtures as listed in the Light Fixture Schedule on the plans. The color temperature of exterior LED fixtures should not exceed 4100K (nominal).
- Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent fixture-to-fixture color for interior fixtures. Exterior fixtures shall use a maximum 5-step MacAdam Ellipse binning process.

- Glare Control: Exterior fixtures shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior fixtures.
- Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- Driver shall have a rated life of 50,000 hours, minimum.
- Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior fixtures, and a minimum of 70 for exterior fixtures.
- LED fixture shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the fixture is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
- LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- All luminaires shall be provided with knockouts for conduit connections.
- The LED lighting fixture shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
- Provide all of the following data on submittals:
  - Delivered lumens
  - Input watts
  - Efficacy
  - Color rendering index.

## FLUORESCENT BALLASTS

All fluorescent ballasts shall be electronic type and shall meet the following specs:

- UL Listed (Class P) sound rating A and CSA certified.
- Comply with EMI and RFI limits set by the FCC (CFR 47 part 18) or NEMA and not interfere with normal electrical equipment.
- Meet any applicable standards set forth by ANSI.
- Be potted or conformal coated in a metallic case and not contain PCBs.
- Provide normal rated lamp life as stated by lamp manufacturers (i.e. rated life at 3 hour burn time per start).
- Provide independent test results from an approved testing laboratory for all of the specifications below. This is required for all submitted ballasts.
- Nominal power factor of .90 or higher.
- Total harmonic distortion of less than 10% at 120 or 277 volts (universal voltage).
- Ballast factor 0.70 through 1.2, as shown on the lighting fixture schedule.
- Frequency of operation shall be 40 kHz - 50 kHz and units shall operate without visible flicker.

- Ballast efficiency factor shall meet Consortium of Energy Efficiency ([www.cee1.org](http://www.cee1.org)) specifications (adopted by Focus on Energy program).
- Multi-lamp ballasts shall operate in parallel so that when one lamp burns out, the other lamps will continue to operate at full light output.
- Ballast Efficiency Factor (BEF) shall be as shown in the table below:

Number of Lamps	Low (BF $\leq$ 0.85)	Normal (0.85 < BF $\leq$ 1)	High (BF > 1.0)
PROGRAMMED-START BALLASTS (T8 lamps)			
1	$\geq 2.84$	$\geq 2.84$	$\geq 2.95$
2	$\geq 1.48$	$\geq 1.47$	$\geq 1.51$
3	$\geq 0.97$	$\geq 1.00$	$\geq 1.00$
4	$\geq 0.76$	$\geq 0.75$	$\geq 0.75$

- Ballasts shall carry a minimum 5 year warranty with a \$10 replacement labor allowance.
- Ballasts shall not be affected by lamp failure.
- Ballasts shall be a standard production item.
- Ballasts shall be marked with manufacturer's name, part number, supply voltage, power factor, open circuit voltage, current draw for each lamp type and UL Listing.
- Ballasts shall withstand line transients as defined in IEEE 587, Category A.
- **SYSTEM PERFORMANCE:** System performance for programmed-start ballasts shall be as follows:

1. Programmed-Start, Low Ballast Factor (BF = 0.71)

Lamps	Nominal Lamp Watts	System Input (Watts @ Univ Volt)
1 – F32T8	32	25
2 – F32T8	32	47
3 – F32T8	32	73
4 – F32T8	32	93

2. Programmed-Start, Normal Ballast Factor (BF = 0.88)

Lamps	Nominal Lamp Watts	System Input (Watts @ Univ Volt)
1 – F32T8	32	31
2 – F32T8	32	60
3 – F32T8	32	88
4 – F32T8	32	118

Acceptable ballast manufacturer's names and product lines are as follows:  
 Osram Sylvania – Quicktronic High Efficiency and Quicktronic PROstart.  
 GE Lighting – Ultramax and UltraStart.  
 Maxlite – High Efficiency Ballast.  
 Advance – Optanium.  
 Universal Lighting Technologies – F32T8.

Manufacturer names are used to develop quality and performance requirements only. All manufacturers and their products shall meet the system performance requirements and this entire specification.

**STEP-DIMMING BALLASTS (Fluorescent)**

All fluorescent ballasts shall be electronic type and shall meet the following specs:

- **Not for use with energy saving T8 lamps.**
- Programmed Start type.

- Easily switched from 100% to 50% power with standard wall switches or occupancy sensor-controlled contacts. Both switch-leg inputs shall control the 50% of the fixture's light output equally.
- UL Listed (Class P) sound rating A and CSA certified.
- Comply with EMI and RFI limits set by the FCC (CFR 47 part 18) or NEMA and not interfere with normal electrical equipment.
- Meet any applicable standards set forth by ANSI.
- Be potted or conformal coated in a metallic case and not contain PCBs.
- Provide normal rated lamp life as stated by lamp manufacturers (i.e. rated life at 3 hour burn time per start).
- Provide independent test results from an approved testing laboratory for all of the specifications below. This is required for all submitted ballasts.
- Nominal power factor of .90 or higher.
- Total harmonic distortion (THD) of less than 10% at full power, THD of less than 20% at 50% power.
- Ballast factor of 0.87 or higher at full power.
- Frequency of operation shall be 40 kHz - 50 kHz and units shall operate without visible flicker.
- Ballast efficiency factor shall meet Consortium of Energy Efficiency ([www.cee1.org](http://www.cee1.org)) specifications (at full power).
- Multi-lamp ballasts shall operate in parallel so that when one lamp burns out, the other lamps will continue to operate at normal light output.
- Ballasts shall carry a minimum 5 year warranty with a \$10 replacement labor allowance.
- Ballasts shall not be affected by lamp failure.
- Ballasts shall be a standard production item.
- Ballasts shall be marked with manufacturer's name, part number, supply voltage, power factor, open circuit voltage, current draw for each lamp type and UL Listing.
- Ballasts shall withstand line transients as defined in IEEE 587, Category A.
- Ballast shall have internal fusing.
- Operating temperature shall not exceed 70° C on the case during normal operation.
- Minimum lamp starting temperature shall be 10°C / 50° F.

### **PART 3 - EXECUTION**

#### **INSTALLATION**

Verify ceiling types with Architectural plans or with existing ceilings. Verify specified fixtures are compatible with specified ceiling type(s) prior to ordering fixtures.

Install in accordance with manufacturer's instructions.

Install suspended luminaires using aircraft cable, or pendants supported from swivel hangers. Heavy duty chain supports may be used where indicated on the fixture schedule. Provide aircraft cable, pendants, or chain lengths required to suspend luminaire at indicated height. All aircraft cables or pendant supported luminaires shall have an independent support to structure at all cable or pendant support locations. When chain is used, tie-wrap the fixture whip to the chain.

Support luminaires larger than 2 x 4 foot (600 x 1 200 mm) size independent of ceiling framing.

Provide independent support for all fixtures over 50 lbs.

Locate ceiling luminaires as indicated on reflected ceiling plan.

Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

The Contractor shall install fixture supports as required. Fixture installations with fixtures supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to

support all lighting fixtures adequately, providing extra steel work for the support of fixtures if required. Any components necessary for mounting fixtures shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.

Install recessed luminaires to permit removal from below.

Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

Install code required hardware to secure recessed grid-supported luminaires in place.

Install wall mounted luminaires and exit signs at height as scheduled. Use pendants supported from swivel hangers in exposed ceiling/structure locations where necessary to mount exit signs at the specified height.

Install accessories furnished with each luminaire.

Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

Bond fixtures and metal accessories to branch circuit equipment grounding conductor.

Install specified lamps in each luminaire and exit sign.

Dimmed fixture circuits shall have separate neutrals.

Dimmed LED fixtures shall have a positive OFF, which requires turning off the circuit to the fixture so that the fixtures don't "glow" at the lowest dimmed setting. This shall be accomplished using a switch, relay, or some other means acceptable to DFD.

All lamps shall be delivered to the job in sealed cartons and protected from dirt and dust during storage on the project. Lamps shall be taken directly from the cartons and installed in the fixture with special care so that they do not become dusty and are not soiled in the operation.

Lamps installed in fixtures using dimming ballasts shall be burned in at 100% rated output by the contractor for a minimum of 100 hours as recommended by the ballast manufacturer.

All new lamps shall be operational at the Substantial Completion of the project.

#### **ADJUSTING AND CLEANING**

Align luminaires and clean lenses and diffusers at completion of Work. Clean paint splatters, dirt, and debris from installed luminaires.

Aim and adjust luminaires as indicated on Drawings or as directed by the A/E.

Touch up luminaire finish at completion of work.

#### **INTERFACE WITH OTHER PRODUCTS**

Provide controls as indicated on the plans. Refer to section 26 27 26 - Wiring Devices. Controls shall be compatible with the fixtures/ballasts/drivers being installed.

#### **FIELD QUALITY CONTROL**

Operate each luminaire after installation and connection. Inspect for proper connection and operation.

#### **ALL FIXTURE CONNECTIONS INCLUDING MASTER-SLAVE**

Direct box or conduit connections for surface and recessed fixtures: Use flexible metal conduit from a J-box for recessed lay-in light fixtures. Flexible metal conduit shall be 3/8" (10 mm) minimum diameter and six foot (1.8 m) maximum length. Flexible whip between master and slave

1 fixtures may be supported off of the ceiling grid wires. Conduit length shall allow movement of the  
2 fixture for maintenance purposes. Minimum wire size shall be #18 AWG for single fixture or  
3 master-slave fixture.

4  
5 The flexible connectors shall be steel or die-cast, galvanized, snap-in type with locknut, clamp  
6 type with locknut, or snap-in connector including those used on the master-slave unit.

#### 7 8 **CONSTRUCTION VERIFICATION**

9 Contractor is responsible for utilizing the construction verification checklists supplied under  
10 specification Section 26 08 00 in accordance with the procedures defined for construction  
11 verification in Section 01 91 01 or 01 91 02.

#### 12 13 **AGENCY TRAINING**

14 All training provided for agency shall comply with the format, general content requirements and  
15 submission guidelines specified under Section 01 91 01 or 01 91 02.

16  
17  
18 **END OF SECTION**



DIVISION 27 - COMMUNICATIONS

**SECTION 27 05 53**  
**IDENTIFICATION FOR COMMUNICATIONS SYSTEMS**  
*BASED ON DSF MASTER COMMUNICATION SPEC DATED 10/01/2012*

**PART 1 - GENERAL**

**CONTENTS**

PART 1 - GENERAL

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EQUIPMENT ROOM AND FITTINGS

PATHWAYS

HORIZONTAL CABLE AND TERMINATION HARDWARE

TERMINATION BLOCKS

**SCOPE**

This Section describes the general, product and execution requirements relating labeling of all communications cabling, terminations and related sub-systems for the Project.

Unless specifically included in this Section, requirements for labeling of pathway items – Junction and Pull Boxes, Communication Conduit, Surface Raceway, and Cable Tray – are covered in the respective Division 26 and/or 27 Sections covering those items.

Provide all labeling as detailed in this and related Sections.

**RELATED WORK**

Section 26 05 53 - Identification for Electrical Systems; re: labeling of conduit, boxes, etc.

Section 26 05 26 - Grounding and Bonding for Electrical Systems; re: component labeling.

Section 27 10 00 - Structured Cabling

**REGULATORY AND STANDARDS REFERENCES**

ANSI/TIA-606-B - Administration Standard for Telecommunications Infrastructure

**SUBMITTALS**

Refer to Section 27 10 00 – Structured Cabling.

**PART 2 - PRODUCTS**

**GENERAL**

All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED unless specifically exempted by the language of this Section.

Labels and markings shall be physically and chemically resistant to damage that would affect readability.

1 Embossed tape will not be permitted for any application.

2  
3 Labels shall match hardware layout and design, and shall be as large as possible while fitting  
4 properly.

5  
6 Refer to Part 3 for labeling formats and content.

7  
8 Use of installing company logo on any labeling is not permitted.

## 9 10 **EQUIPMENT ROOM AND FITTINGS**

### 11 **Backboard**

12 Adhesive Label or Stencil.

13  
14 Character height shall be 2-inch (minimum).

### 15 16 **Equipment Racks and Cabinets**

17 Adhesive Label.

18  
19 Character height shall be 1-inch (minimum).

### 20 21 **Equipment Enclosures**

22 Adhesive Label.

23  
24 Character height shall be 1-inch (minimum).

## 25 26 **CABLE AND TERMINATION HARDWARE**

### 27 **Cable Labels**

28 Labels shall be White Vinyl or other appropriate substrate and incorporate a clear lamination that,  
29 when label is wrapped around cable, covers printed part of label. Flag type labels are not  
30 allowed.

31  
32 Labels shall be of adequate size to accommodate circumference of cable(s) being marked and  
33 properly self-laminate over full extent of printed area of label.

- 34 • Labels on larger cables (e.g. Copper Backbone) may be wrapped with clear non-removable  
35 tape.

### 36 37 **Telecommunications Outlet**

38 Telecommunications Outlet labels that are placed in recessed label holders shall be white paper  
39 on which outlet information is added.

### 40 41 **Modular Patch Panel**

42 Paper Inserts integral to patch panel, Adhesive labels or factory-screened numbering.

### 43 44 **Termination Blocks**

45 Labels for 110-type Termination Blocks shall be paper inserts and be color-coded to indicate the  
46 block's place in the cabling hierarchy (backbone, horizontal, etc.). Refer to Part 3 for insert  
47 colors.

## 48 49 **MISCELLANEOUS**

50 None

## 51 52 53 **PART 3 - EXECUTION**

### 54 55 **GENERAL**

56 Clean surfaces before attaching labels with the label manufacturer's recommended cleaning  
57 agent.

58  
59 Install labels firmly as recommended by the label manufacturer.

Install labels square and neatly on all equipment.

Position labels as to be visible and not obscured by termination hardware or other cabling.

Lettering shall be 10-point or larger unless noted otherwise.

## EQUIPMENT ROOM AND FITTINGS

## General

Designators for communications equipment rooms shall be as follows:

Telecommunications Room (TR) [TR]

Telecommunication Room identifiers shall be unique in each building.

## Backboard

Label Backboards with room designator.

Position label on wall adjacent to entry door.

### Equipment Racks and Cabinets:

Label each Equipment Rack and/or Cabinet with [a unique alpha character starting at "A".

Position labels at top of rack. Label may be center, left or right for best visibility.

### Equipment Enclosures:

Label each Equipment Enclosure with designation for Telecommunications Enclosure.

## HORIZONTAL CABLE AND TERMINATION HARDWARE

## General

Label all Telecommunications Outlets, Patch Panels, Termination Blocks, and Cables.

This is inclusive of each voice, data, video, or fiber optic outlet, or any configuration thereof, as identified on the Drawings.

Label each component using a unique code identifying the link.

## Telecommunications Outlet

Telecommunications Outlet identification shall be based on - or result in – a logical numbering sequence in each Work Area. Labeling plans that results in random TO numbering are not acceptable.

Label Telecommunications Outlets on the faceplate and, if applicable, on the base or frame of the TO which is permanently attached to its mounting.

Where outlet faceplates incorporate recessed label holders, labels shall be positioned beneath clear plastic covers that are part of the faceplate assembly. Where no such label holders are present (e.g. on existing to remain outlets or wall-mounted telephone-only outlets) protect the faceplate labels with a clear over-laminate.

Labels shall be White background with Black lettering. Lettering size shall be as large as practicable (up to 16-point) to fit properly on the outlet label. No lettering shall be smaller than 12-point.

Where there is a distinction between "Voice" and "Data", number each media type separately. Where there is no distinction between horizontal cabling that may be used for "Voice", "Data", "CATV", "IPTV", etc., number the media types sequentially.

The format of the Telecommunications Outlet identifier shall be as follows:

1 HC-RPP-##

2 where: HC = Identifier serving that location

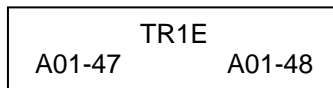
3 R = Designation for Equipment Rack where cable is terminated; an Alpha character  
4 starting at "A".

5  
6 PP = Designation for the Patch Panel on which cable is terminated at the HC; a  
7 number starting at "01". Panels are to be numbered be from Top (of Rack) to Bottom.

8  
9 ## = Sequential position of the Jack on the Panel; A numerical value of 01 - 48 is  
10 typical starting at the top left and counting from Left-to-Right.

11  
12 For example: "1E-A03-25" represents a cable terminated in the 25th Jack Position in 3rd  
13 Panel on Equipment Rack "A" at the Horizontal Cross-connect identified as "1E".

14  
15 Faceplate labels can use common HC identifiers on each label strip. For example, two links that  
16 terminate in the room designated as "TR1E" on positions "47" and "48" of Patch Panel "01"  
17 located on Rack "A" and sharing common label strip may be represented by:



## 22 Horizontal Cable

23 Code used to label Horizontal Cables shall be same as identified for Telecommunications Outlet  
24 above.

25  
26 Label each Horizontal Cable at the Horizontal Cross-connect (e.g. Modular Patch Panel or  
27 Termination Block) and at the Telecommunications Outlet. If applicable, label cables at an  
28 intermediate interconnect such as a Consolidation Point in a Zone Cabling installation.

29  
30 At a Telecommunications Outlet or Modular Patch Panel, position labels within 4-inches of  
31 each cable end.

32  
33 At a Termination Block, position label so that it is not obscured by the designation strip  
34 (labeling) on the block.

## 35 Modular Patch Panels

36 Label each Patch Panel and port at horizontal cross-connect with unique identifying code. Code  
37 shall identify Outlet ID that corresponds with each jack/connector position.

38  
39  
40 Horizontal Cross-connect (location) identifier is not required on modular patch panels.

41  
42 Equipment Rack identifier is not required on modular patch panels.

43  
44 Modular Patch Panel labeling format shall be as follows:

- 45 • Label each Modular Patch Panel with its designator "PP". This is a number starting at "01".  
46 Panels are to be numbered be from Top (of Rack) to Bottom.
- 47 • Label each jack position sequentially with its designator "##". A numerical value of 01 - 48 is  
48 typical starting at the top left and counting from Left-to-Right and Top-to-Bottom. Use of  
49 factory-screened numbering is preferred

## 50 TERMINATION BLOCKS

### 51 General

52 Provide color-coded Designation Strips with Termination Blocks.

53  
54 Label termination positions on Designation Strips with identifier.

55  
56 Label each Designation Strip with (2) rows of identifiers. Identifiers on "upper" row on each strip  
57 refer to cable positions ABOVE the label; identifiers on the "lower" row refer to cable positions  
58 BELOW the label.

## Horizontal Cabling

Designation Strips for Blocks on which Horizontal Cabling is terminated shall be BLUE.

Code used to label Designation Strips shall be same as identified for Telecommunications Outlet above. Label each position.

Horizontal Cross-connect (location) identifier is not required on Termination Blocks.

Example: Designation Strip for block on which "Voice" cables 001V – 012V are terminated would appear as follows:

----- Conductor Positions -----

001V	002V	003V	004V	005V	006V
007V	008V	009V	010V	011V	012V

----- Conductor Positions -----

## Voice Multiplier

The following assumes creation of a Voice "Multiplier" Block using 100-pair blocks which have been wired to make each pair position in a row common with the comparable position in each other row.

Designation Strips for Voice Multiplier Blocks shall be YELLOW.

Label Designation Strips with:

- Designation as "MULTIPLIER". Repeat on every designation strip.
- Row designator - Label 25-pair rows in 100-pair multiplier block as "A" (1st 25-pair), "B" (2nd 25-pair), "C" and "D".
- Pair Number. Label 1st and 25th Positions on each row (e.g. 001 and 025).

Example: Designation strips (2) for 25-pair multiplier (4 x 25 pair = 100-pair block) would appear as follows:

----- Conductor Positions -----

A001	MULTIPLIER	A025
B001		B025

----- Conductor Positions -----

----- Conductor Positions -----

C001	MULTIPLIER	C025
D001		D025

----- Conductor Positions -----

## Network Connection Cabling

Designation Strips for Blocks on which cabling from Access/Service Provider (Feed) is terminated shall be GREEN.

Label Designation Strips with:

- Designation as "NETWORK (PROVIDER NAME)". Repeat on every designation strip.
- Pair Number.

Example: Designation strip for block on which Service Provider (AT&T in this example) pairs 1001 – 1050 are terminated would appear as follows:

----- *Conductor Positions* -----

1001	NETWORK (AT&T)	1025
1026		1050

----- *Conductor Positions* -----

**END OF SECTION**

DIVISION 27 - COMMUNICATIONS

**SECTION 27 08 00**  
**COMMISSIONING OF COMMUNICATIONS**  
*BASED ON DFD SPECIFICATION DATED 03/01/14*

**PART 1 - GENERAL**

**SCOPE**

This section includes commissioning forms for construction verification and functional performance testing. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- Related Work
- Reference
- Submittals

**PART 2 - PRODUCTS**  
(Not Used)

**PART 3 - EXECUTION**

- Commissioning Forms
  - CV-27 05 53 Identification for Communications Systems
  - CV-27 10 00 Structured Cabling
  - CV-27 11 00 Communications Equipment Room Fittings

**RELATED WORK**

Section 01 91 01 or 01 91 02 - Commissioning Process

**REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

**SUBMITTALS**

Reference the General Conditions of the Contract for submittal requirements.

Reference Section 01 91 01 or 01 91 02 Commissioning Process for Construction Verification Checklist and Functional Performance Test submittal requirements.

**PART 2 – PRODUCTS**

(Not Used)

**PART 3 – EXECUTION**

**COMMISSIONING FORMS**

Commissioning forms are to be filled in as work progresses by the individuals responsible for installation and shall be completed for each installation phase.

Provide a description of the work completed since the last entry, the percentage of the total work completed for the system for that area and the step of installation or finalization.

Circle Yes or No for each commissioning form item. If the information requested for an item does not apply to the given stage of installation for the system, list it as "N/A". Explain all discrepancies, negative responses or N/A responses in the negative responses section.

Once the work is 100% complete and the responses to each item are complete and resolved for a given commissioning forms group, mark as complete, initial and date in the spaces provided.

1 Provide copies of the commissioning forms to the commissioning agent 2 days prior to  
2 construction progress meetings.

3

4

**END OF SECTION**

5

6

7

8



## CV-27 05 53 – Identification for Communication Systems

Equipment Identification/Tag: \_\_\_\_\_  
Location: \_\_\_\_\_

### A) LABELING

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)										
				1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:		DATE:								

### Question Details

- 1) Telecommunications Outlet faceplates labeled as specified.
- 2) Cabling at Telecommunications Outlet labeled as specified.
- 3) Modular Patch Panels for Horizontal Copper Cable labeled as specified.
- 4) Termination Blocks for Horizontal Copper Cable (if applicable) labeled using correct color-coded (BLUE) Designation Strips
- 5) Termination Blocks for Backbone Copper Cable (if applicable) labeled using correct color-coded (WHITE, GRAY or BROWN) Designation Strips
- 6) Fiber Optic Patch Panels for backbone fiber optic cabling labeled as specified.
- 7) Copper Cabling at Modular Patch Panels and Termination Blocks at Main Equipment Room and Telecom Room(s) labeled in accordance with specification requirements.
- 8) Fiber Optic Cabling at Patch Panels at Main Equipment Room and Telecom Room(s) labeled in accordance with specification requirements.
- 9) Innerduct for backbone fiber optic cabling (if applicable) labeled as specified.
- 10) Backboard, Equipment Racks and Cabinets, and Enclosures labeled as specified.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

## CV-27 10 00 – Structured Cabling

Equipment Identification/Tag: \_\_\_\_\_  
Location: \_\_\_\_\_

### A) HORIZONTAL CABLING IN CONDUIT - INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)								
				1)	2)	3)	4)	5)	6)	7)	8)	
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS: _____				DATE: _____				

### Question Details

- 1) Exposed cabling has been visually inspected for physical damage and any damaged cabling has been replaced. Cabling jacket and insulation are in good condition.
- 2) Cable color(s) matches specification requirements for given cable type.
- 3) Cable listing (e.g. General Purpose, Riser, Plenum) as specified and appropriate for installation environments.
- 4) Conduits swabbed to remove foreign material prior to pulling cables.
- 5) Cables pulled though conduit at the same time, with pulling lubricant used as required to ease pulling tensions.
- 6) Cabling is splice free.
- 7) Bend radii conforms to manufacturer recommendations for each cable type.
- 8) Appropriate slack provided in length required by specifications for given cabling type and termination point.

### Negative Responses

Group/Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

## B) UNENCLOSED HORIZONTAL CABLING - INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)								
				1)	2)	3)	4)	5)	6)	7)	8)	
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:				DATE:				

### Question Details

- 1) Exposed cabling has been visually inspected for physical damage and any damaged cabling has been replaced. Cabling jacket and insulation are in good condition.
- 2) Cable color(s) matches specification requirements for given cable type.
- 3) Cable listing (e.g. General Purpose, Riser, Plenum) as specified and appropriate for installation environments.
- 4) Cabling supported via "J-hook" or "bridal-type" supports at spacing defined within specifications. (Bridal-type supports configured with bend-radius control.)  
Supports are independent of piping, ductwork, equipment, cable tray or other conduit.
- 5) Minimum separations provided for cabling per specifications to minimize EMI.
- 6) Cabling is splice free.
- 7) Bend radii conform to manufacturer recommendations for each cable type.
- 8) Appropriate slack provided in length required by specifications for given cabling type and termination point.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

### C) TELECOMMUNICATIONS OUTLET - INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)										
				1)	2)	3)	4)	5)	6)	7)	8)	9)		
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:				DATE:						

### Question Details

- 1) Telecommunications Outlet faceplate material and color are as specified.
- 2) Outlets installed at locations and heights specified in contract documents for given outlet type.  
Outlets mounted at same height for given outlet type throughout facility.
- 3) Outlets are level.
- 4) Outlets are flush to finished surface.
- 5) Connector types and colors are as specified.
- 6) Connector positions and faceplate layout are as specified. Faceplate layout for a given configuration is same throughout installation.
- 7) Unused connector positions fitted with a blank insert color-matched to the faceplate color.
- 8) Connectors fitted with Dust Covers as specified and as applicable.
- 9) Outlets secured using tamper-resistant fasteners (if applicable).

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

## D) HORIZONTAL CABLING AT EQUIPMENT ROOM - INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)					
				1)	2)	3)	4)	5)	6)
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:			DATE:		

### Question Details

- 1) Modular Patch Panels and Termination Blocks provided as specified.
- 2) Cable is supported at rear of Patch Panels and at entry to Termination Blocks.
- 3) Copper Twisted Pair terminated as specified. Cable jacket is removed only to the extent required for termination and within manufacturers recommended limits.  
Cable pairs untwisted only to the extent required for termination and within manufacturers recommended limits.
- 4) Coaxial cabling terminated and secured as specified.
- 5) Cabling secured using hook-and-loop ties within the room.
- 6) Horizontal Jumper Management in place on Equipment Racks as specified.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

## E) BACKBONE CABLING - INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)									
				1)	2)	3)	4)	5)	6)	7)	8)	9)	
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:						DATE:			

### Question Details

- 1) Fiber Optic Patch Panels and Termination Blocks provided as specified.
- 2) Unused Fiber Optic Patch Panel positions fitted with blanks or cover plates as applicable.
- 3) Cable color(s) matches specification requirements for given cable type.
- 4) Cable listing (e.g. General Purpose, Riser, Plenum) as specified and appropriate for installation environments.
- 5) Cabling supported within equipment rooms and in vertical chases as specified. Supports are independent of piping, ductwork, equipment, cable tray or other conduit. Wire-mesh-type support grips or other approved means used where cable must bear stress.
- 6) Appropriate slack provided in length required by specifications for given cabling type and termination point.
- 7) Cabling is splice free.
- 8) Fiber Optic Duplex Coupling orientation (e.g. A-B, B-A) is as specified. Fibers positioned in sequence; positions are same at both ends of cable.
- 9) Metallic Cable armor and/or Shielding bonded to telecommunications ground.

### Negative Responses

Group/Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

## F) CABLING AND PATHWAYS (GENERAL) - INSTALLATION CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)						
				1)	2)	3)	4)	5)	6)	7)
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:			DATE:			

### Question Details

- 1) Cable bend radii conform to manufacturer recommendations for given wire type and gauge.
- 2) Penetrations through floor and rated walls are sealed as specified using an Assembly rated for the wall or floor penetrated.
- 3) Penetrations through non-rated walls are sealed as specified for given space type.
- 4) Communications Cabling pulled in separate conduits from normal power, emergency power, security and control systems.
- 5) Conduit junction boxes are painted and tagged in accordance with specification requirements.
- 6) Pull cord provided in each conduit. Includes occupied and vacant conduit.
- 7) Cross-connects are complete and documented as specified.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

## G) TESTING CHECKS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)						
				1)	2)	3)	4)	5)	6)	7)
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS:			DATE:			

### Question Details

- 1) Maximum Horizontal Cable (Voice & Data) length is less than 295'.
- 2) Copper Horizontal Twisted-pair Cabling Tested and Documented as specified.
- 3) Copper Backbone Twisted-pair Cabling Tested and Documented as specified.
- 4) Copper Horizontal Coax Cabling Tested and Documented as specified.
- 5) Copper Backbone Coax Cabling Tested and Documented as specified.
- 6) Fiber Optic Backbone Cabling Tested and Documented as specified.
- 7) Shielded cabling shield and drain wire continuity tested and results are acceptable.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		



## CV-27 11 00 – Communications Equipment Room Fittings

Equipment Identification/Tag: \_\_\_\_\_  
Location: \_\_\_\_\_

### A) EQUIPMENT RACKS, CABLE RUNWAY AND MISCELLANEOUS EQUIPMENT ROOM FITTINGS

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)					
				1)	2)	3)	4)	5)	6)
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
<input type="checkbox"/> CHECKLIST GROUP COMPLETE				INITIALS: _____		DATE: _____			

### Question Details

- 1) Equipment Rack(s) and/or Cabinet(s) installed as specified, including clearances, anchoring to floor and side bracing.
- 2) Equipment Rack(s) configured with vertical management per specification.
- 3) Cable Runway installed per specification.
- 4) Drop-outs in place where cable exits cable runway to equipment rack to control cable bending to within bend-radius specifications.
- 5) Equipment Rack(s), cable runway and other hardware as specified bonded to Telecommunications Ground (TGB or TGM) in accordance specification requirements. Rack or cabinet finish (paint) removed at point-of-contact with grounding hardware.
- 6) Power Strip / Surge Suppressor installed per specification.

### Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved YES / NO	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

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DIVISION 27 - COMMUNICATIONS

**SECTION 27 10 00**  
**STRUCTURED CABLING**

*BASED ON DFD MASTER COMMUNICATION SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

**SCOPE**

This section describes the products and execution requirements relating to furnishing and installation of Telecommunications Cabling and Termination Components and related sub-systems as part of a Structured Cabling System for the project.

Included are the following topics:

**PART 1 - GENERAL**

- SCOPE
- RELATED WORK
- REGULATORY AND STANDARDS REFERENCES
- DESIGN INTENT
- WORK SEQUENCE
- SUBMITTALS
- WORK BY STATE AND/OR USER AGENCY
- COOPERATION
- PROJECT RECORD DOCUMENTS
- QUALITY ASSURANCE
- DELIVERY, STORAGE AND HANDLING
- DRAWINGS
- OMISSIONS

**PART 2 - PRODUCTS**

- HORIZONTAL CABLING
- TELECOMMUNICATIONS OUTLET
- MODULAR PATCH PANEL
- HORIZONTAL JUMPER MANAGEMENT
- VOICE TERMINATION FIELD
- MISCELLANEOUS MATERIALS

**PART 3 - EXECUTION**

- GENERAL
- CABLE INSTALLATION
- BUILDING ENTRANCE TERMINAL
- TELECOMMUNICATIONS OUTLET
- CABLE TERMINATION
- IDENTIFICATION AND LABELING
- TESTING AND ACCEPTANCE
- DOCUMENTATION
- AS-BUILT CONSTRUCTION DRAWINGS
- WARRANTY
- AS-BUILT COMMUNICATION CABLE COSTS
- CONSTRUCTION VERIFICATION

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

- Section 26 05 00 - Common Work Results For Electrical
- Section 26 05 26 - Grounding and Bonding for Electrical Systems
- Section 26 05 29 - Hangers and Supports for Electrical Systems
- Section 26 05 33 - Raceway and Boxes for Electrical Systems
- Section 26 05 53 - Identification for Electrical Systems
- Section 27 05 53 - Identification for Communications Systems
- Section 27 08 00 - Commissioning of Communications
- Section 27 11 00 - Communications Equipment Room Fittings

**REGULATORY AND STANDARDS REFERENCES**

All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Wisconsin Electrical Code and present manufacturing standards.

All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

Other applicable standards are as follows:

#### General

- ANSI/IEEE C2 - National Electrical Safety Code
- NFPA 70- 2011 - National Electrical Code
- SPS Chapter 316 – Wisconsin Dept. of Safety and Professional Services Electrical Code

#### Structured Cabling and Infrastructure

- ANSI/TIA-568-C.0, -568-C.1, -568-C.2, -569-C, -606-B and ANSI-J-STD-607-B (with exception) and TIA/EIA Standards referenced therein.
- IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- ICEA publication S-80-576-2002
- TIA/EIA Standards 526-14A (OFSPT-14A), 526-7 (OFSPT-7)

### **DESIGN INTENT**

#### **General**

The Structured Cabling System is based on a hierarchy of cables and termination locations.

All cables and related termination, support and grounding hardware, bonding, shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following sections.

Provide all labor and materials necessary to construct the system as described herein. This includes - but is not limited to - furnishing and installing cable, cable supports, innerduct, racking and termination components, termination, testing, labeling, and documentation.

#### **Horizontal Cabling**

Horizontal Cabling System links the Telecommunications Outlet (TO) in the work area to the Horizontal Cross-connect serving that area (e.g. Telecommunications Room (TR) or Equipment Room (ER)). This "Permanent Link" includes 4-Pair Unshielded Twisted Pair (UTP) Copper Cables, terminated as specified in this document.

Separate Horizontal Cables designated for "DATA" and "VOICE" (Telephone) shall support each application.

Horizontal Cables for network-type Security devices (e.g. IP Video Surveillance Camera), if applicable, are considered "Data" cables for the purpose of this specification.

Performance of the Horizontal Permanent Link (cable + termination hardware) shall be as follows:

- Cabling designated for "Voice" - Exceed TIA Category 6
- Cabling designated for "Data" - Exceed TIA Category 6

Termination Hardware for Horizontal Cabling shall be rack-mounted Patch Panel.

Termination Hardware for Horizontal Cabling shall be as follows:

- Cabling designated for "Voice" - rack-mounted Patch Panel
- Cabling designated for "Data" - rack-mounted Patch Panel

### **WORK SEQUENCE**

During the construction period, coordinate telecommunications schedule and operations with the State of Wisconsin, Division of Facilities Development Construction Representative and Owner.

### **SUBMITTALS**

#### **General**

Under the provisions of Division 1 (incl. 01 91 01 or 01 91 02), prior to the start of work, submit:

- Shop Drawings
- Schedule of Values
- Bidder Qualifications

Group Submittals to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, mark dimensions in units to match those specified.

Submittals shall be original catalog sheets, photocopies, or electronic format (ADOBE Portable Document format ".pdf") thereof. Facsimile (fax) sheets shall not be accepted.

All drawings by Contractor referred to as "Shop Drawings", "As-Built" or "Record" drawing sets shall be drafted electronically and submitted to Engineer as Full Size PDF's unless stated otherwise.

- Upon request, Contractor shall provide electronic AutoCAD (.dwg) files of their drawings at no additional cost to Owner.

The Engineer shall review the Submittals and through annotation and/or a cover sheet, provide comment.

Work shall not proceed without the Engineer's review of the submitted items.

#### **Shop Drawing Submittal**

Submit documents including:

- Manufacturer's Product data for all products proposed indicating construction, materials, ratings, and all other parameters identified in Part 2 (Products) below.

Structured Cabling submittal shall include Test Data confirming Horizontal Cabling Channel Performance.

- Manufacturer's installation instructions.
- Upon request by the Engineer, one (1) two-foot section of each cable type to be utilized for final approval by the Engineer. This two-foot section shall have the manufacturer's cable markings visible. Upon request, samples from every reel sent to the site shall be provided.
- Samples of all label types planned for the Project. These samples shall include examples of the lettering to be used. Mount samples on 8 1/2" x 11" sheets and mark to indicate their proposed use.
- Prior to system tests, submit Test Plan for all cable types per Part 3.

#### **Schedule of Values Submittal**

Submit Schedule of Values consisting of:

- Materials (Line-Item per Class of Material – Horizontal Cable, Backbone Cable, Connectivity, Equipment Racks, etc.)
- Labor – Mobilization
- Labor - Installation
- Labor - Testing
- Labor - Documentation
- Labor - Training
- Additional categories as appropriate

#### **Bidder Qualifications**

Upon request, furnish project list as identified under "Quality Assurance / Bidder Qualifications" below.

Certification documents confirming contractor status as active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used shall be from the manufacturer.

For each project listed provide:

- Name and location of installation.
- Date of initial operation of system by owner. (Minimum period of operation for referenced project shall be 12 months.)
- Owner's representative to contact and their telephone number.

1 **WORK BY STATE AND/OR USER AGENCY**

2 Cross connect cabling.  
3 Voice and Data service and termination to building.  
4

5 **COOPERATION**

6 Cooperate with other trades and State personnel in locating work in a proper manner. Should it  
7 be necessary to raise or lower or move longitudinally any part of the work to better fit the general  
8 installation, such work shall be done at no extra cost to the State, provided such decision is  
9 reached prior to actual installation. The Contractor shall check the location of electrical outlets  
10 with respect to Division 27 outlets and equipment before installing.  
11

12 **PROJECT RECORD DOCUMENTS**

13 Submit record documents under the provisions of Division 1, Specification Section 26 05 00 and  
14 Part 3 of this section.  
15

16 **QUALITY ASSURANCE**

17 **Manufactured Items**

18 The manufacturer(s) of cabling and connectivity components shall be a company specializing in  
19 and having a minimum of five years documented experience in producing products similar to  
20 those specified in this and related sections.  
21

22 **Bidder Qualifications**

23 The contractor shall have been in this line of business for a minimum of five (5) years and have  
24 successfully completed one or more projects of scope 50% or more of the magnitude specified by  
25 these documents.  
26

27 Contractor shall have necessary certifications to provide for Guarantees as specified herein.  
28

29 Contractor shall be an active participant in Installers Program operated by Manufacturer  
30 of Cabling or Termination Components used. Contractor shall be participant in this  
31 program at time of Bidding and remain so throughout project.  
32

33 Contractor shall have on the project team at a minimum one (1) certified Installer trained  
34 by the manufacturer(s) of the cabling, hardware and accessories installed under this  
35 project.  
36

37 At least (1) member of each test team shall be factory trained/certified in use of the test  
38 equipment. The project foreman shall have been factory trained in the use of the test  
39 equipment.  
40

41 **DELIVERY, STORAGE AND HANDLING**

42 Store cable according to manufacturer's recommendations as minimum. In addition, store cable  
43 in a location protected from vandalism and weather. If cable is stored outside, it must be covered  
44 with opaque plastic or canvas with provision for ventilation to prevent condensation and for  
45 protection from weather. If air temperature at cable storage location will be below 4 degrees C.,  
46 move cable to a heated (10 degrees C. minimum) location.  
47

48 If the contractor wishes to have a trailer on site for storage of materials, arrangements shall be  
49 made with the Owner. If necessary, cable shall be stored off site at the contractor's expense.  
50

51 **DRAWINGS**

52 It shall be understood that the electrical and communication details and drawings provided with  
53 the bid documents are diagrammatic. They are included to show intent and to aid the Contractor  
54 in bidding the job. The Contractor shall make allowance in their bid to cover whatever work is  
55 required to comply with the intent of the plans and specifications.  
56

57 The Contractor shall verify all dimensions at the site and be responsible for their accuracy.  
58

## **OMISSIONS**

Prior to submitting the bid, the Bidder shall call the attention of the Engineer to any materials or apparatus the Bidder believes to be inadequate and to any necessary items of work omitted, within ten (10) days prior to the Bid Due Date.

## **PART 2 - PRODUCTS**

### **BACKBONE COPPER DATA CABLING**

Not applicable to this project.

### **HORIZONTAL CABLING**

#### **General**

The Horizontal (Station) Cable System is based on the installation of 4-pair, Un-shielded Twisted Pair (UTP) copper cables from the Telecommunications Outlet to the Horizontal Cross-connect (wiring hub). The combined cable and termination hardware is referred to as the "Permanent Link".

Refer to the Floor plan Drawings(s) which identify the location of the Horizontal Cross-connect and Telecommunications Outlet (TO) locations.

Cable and Termination Components (Jack, Patch Panel / Wiring Blocks) are specified to function as a System. The compatibility of the Cable to be installed with the proposed termination components shall be recognized and documented by the Termination Component Manufacturer.

#### **Performance**

Cable, Component and Permanent Link performance shall exceed the TIA/EIA Category 6 criteria as defined by the referenced TIA/EIA documents. Minimally complaint Category 6 cabling and termination hardware is not acceptable for installation on DFD projects. Compliance shall be determined as follows:

Manufacturer's published literature shall document performance margins over worst-case ANSI/TIA-568-C.2 Category 6 Channel requirements for Power Sum Attenuation-to-Crosstalk Ratio (PSACR).

Margins shall be documented at all frequencies up to and including 250-MHz. (PSACR shall remain positive above the 250-MHz limit considered by the TIA standards.)

Channel, as tested, shall include 4-connections (minimum).

Data shall be verified by an independent source (e.g. ETL. Intertek).

Cable and connecting components that comprise the "Permanent Link" shall meet or exceed the requirements for "DTE Power via the MDI" to provide at least 25 W at the Powered Device as defined by the IEEE 802.3at-2009 "Power over Ethernet Plus (PoE+)" standard.

#### **Horizontal Cable**

All Cables and Termination hardware shall be technically compliant with and installed in accordance with the referenced TIA/EIA documents and perform as required to provide the Permanent Link margins stated herein.

All cables shall be suitable for installation in the environment defined.

Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code and shall meet the specifications of NEMA (low loss), UL 444, and ICEA.

#### **Construction:**

Horizontal Cables shall be constructed of individually twisted pairs with 24-AWG (Category 5e) or 23-AWG (Category 6) - as applicable - insulated solid copper conductors.

Pairs shall be identified by a banded color code in which conductor insulation is marked with a dominant color and banded with a contrasting color as follows:

- Pair 1: White-Blue / Blue (or Blue/White)
- Pair 2: White-Orange / Orange (or Orange/White)
- Pair 3: White-Green / Green (or Green/White)
- Pair 4: White-Brown / Brown (or Brown/White)

Cable Rating: CM (or approved substitutes as defined by the NEC).

Cable Jacket color(s) shall be as follows:

- Data - Blue
- Voice - White

Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

Cable performance shall be as required to meet the criteria defined in the Article "Horizontal Permanent Link" above.

#### **Horizontal Cable Termination**

Refer to Part 1 article "DESIGN INTENT" for termination hardware type(s).

Termination hardware performance shall be as required to meet the criteria defined in "HORIZONTAL CABLING / Performance" above.

#### **TELECOMMUNICATIONS OUTLET**

##### **General**

Station cables shall each be terminated at their designated workstation location in the connector types described in the sub-sections below. Included are Modular Jacks, [Fiber Optic Connectors][and Coaxial Connector assemblies]. These connector assemblies shall snap into a mounting frame. The combined assembly is referred to as the Telecommunications Outlet (TO).

All Telecommunications Outlets and the associated Jacks shall be of the same manufacturer throughout the project.

TO mounting configurations shall be as follows:

- Flush where new boxes are in place.

The Telecommunications Outlet Frame shall accommodate:

- A minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a wall-mounted assembly.

- A minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a Floor-mounted assembly.

- A minimum of two (2) Modular Jacks and/or Coaxial Connectors when installed on modular furniture. Design shall accommodate bend radius of installed cables.

- The outlet frame shall incorporate a mechanism for adjusting the surface plate to a plumb position.

Connectors shall [be flush with the frame/faceplate.][exit the frame/faceplate at a 45 degree angle with the angle facing the floor.]



The same orientation and positioning of Jacks and Connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each TO type for review by the Engineer.

Wall Mount Outlet Faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

Unused jack positions shall be fitted with a removable blank inserted into the opening.

Faceplate of the TO shall be constructed of [High Impact Plastic][Stainless Steel].

Faceplate Color shall (1) match other utilities in the building or (2) when installed in Surface Raceway (if applicable), match the color of the Raceway.

The dust cover shall be designed to remain with the jack assembly when the jack is in use. No damage to the Jack pinning shall result from insertion or removal of these covers. Dust covers, which result in deformation of the jack pinning, shall not be accepted.

#### **Outlet for Wall-mounted Telephone Sets**

Outlets intended for wall-mounted telephone sets shall be installed where identified ("W") on the Project Drawing(s). The Wall Plate shall be of Stainless Steel construction, accommodate one (1) modular jack as previously defined, mounted on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.

#### **4-pair Copper Connector (Modular Jack)**

Connector type for 4-pair UTP cabling shall be an 8-pin, 8-conductor (8P8C) Modular Jack.

The interface between the jack and the 4-pair cable shall be a 110-Style block or other insulation-displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination

Modular Jacks shall be pinned per TIA standards as follows:

Data - T568B

Voice - T568B

Modular Jacks shall be UL verified and listed.

Modular Jack spring wire contacts shall have a minimum of 50 micro-inches of gold plating.

Modular Jack color(s) shall be as follows:

Data - Blue

Voice - White

Modular Jack performance shall be as required to meet the specified Permanent Link and Channel performance.

#### **MODULAR PATCH PANEL**

Patch Panels shall be a Modular to 110-type connector system incorporate Modular Jacks meeting the specifications for the Telecommunications Outlet detailed in the Section above.

Jack color is not applicable unless noted otherwise.

Modular Patch Panel shall be rack-mounted.

Rack –mounted panel shall be Flat.

On Wall-mounted panels:

- Cable interface shall be on the front of the panel (same size as modular jacks) and be protected by a cover plate when in use.
- Shall incorporate a standoff bracket to allow for cabling to be routed behind the panel.

Modular Patch Panel configuration shall not exceed 48 ports (2 rows of 24 ports each) in a 2 RU panel.

Panel designs which feature removable modular jack assemblies shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12-jacks.

Modular Patch Panel cable termination shall:

- Have the ability to seat and cut 8 conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors.
- Be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
- Include color coded designation strips or other markings to identify conductor position.

Modular Patch Panels shall incorporate cable support and/or strain relief mechanisms to secure cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

Modular Patch Panel performance shall be as required to meet the specified Permanent Link and Channel performance.

## **HORIZONTAL JUMPER MANAGEMENT**

Equipment Rack shall be equipped with Horizontal Jumper Management Hardware as to allow an orderly routing of twisted pair, optical fiber and coaxial jumpers from the patch panels to the customer provided network equipment. Jumper management hardware shall be as follows:

Panels shall be painted steel or plastic (3.5" panel), have a minimum of five (5) Jumper distribution rings (1.75" x 3.75" minimum dimension).

## **VOICE TERMINATION FIELD**

### **General**

Blocks shall be 110-type.

The mechanical termination shall:

Have the ability of terminating 22 - 26 AWG plastic insulated, solid and stranded copper conductors.

Provide a direct connection between the cable and jumper wires.

Each row of blocks shall be provided with a label holder which is to be used to identify the cable pairs. Label shall be color coded to indicate cabling type. Refer to specification Section 27 05 53 - Identification for Communications Systems for Label color and marking requirements.

Blocks shall identify pair position by a color designation - Blue, Orange, Green, Brown and Slate (Backbone only).

The blocks shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.

Wall mounted patch panels and terminal blocks must be mounted on a prepared surface consisting of 5/8 inch plywood securely fastened to the building walls. All six surfaces of the plywood must be painted with fire retardant paint.

Where wall-mounted blocks are specified:

Provide Horizontal Troughs incorporating plastic or metal distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block.

Provide metal or plastic split distributing rings on both sides of the column of blocks to accommodate vertical routing of jumpers.

Where Horizontal and Backbone Cabling blocks are oriented vertically (rather than side-by-side), provide a backboard incorporating plastic distribution rings allowing for a change in direction in cross connect wiring between the blocks of each type.

### **Configuration for Horizontal Cabling**

At the Horizontal Cross-connect, Blocks shall be [wall][rack]-mounted.

Each horizontal row shall be cable of terminating six (6) four pair groups (Horizontal Cable).

Four (4) Pair Termination Clips (e.g. C4) shall be used in the termination of Voice Horizontal Cable.

Termination Block performance shall be as required to meet the criteria defined in the Article "Horizontal Permanent Link" above.

### **MISCELLANEOUS MATERIALS**

None required.

## **PART 3 - EXECUTION**

### **GENERAL**

Refer to Project Drawings which indicate Telecommunications Outlet locations, major cable routes and termination location(s) within each building. Coordinate duct allocation with the Agency.

Furnish and install all cables, connectors, hardware and equipment as shown on drawings and as specified above.

It is the contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

The contractor will be responsible for identifying and reporting to the DFD Construction Representative any existing damage to walls, flooring, tiles and furnishings in the work area prior to start of work. All damage to interior spaces caused by the installation of cable, raceway or other hardware must be repaired by the Contractor. Repairs must match preexisting color and finish of walls, floors and ceilings. Any contractor-damaged ceiling tiles are to be replaced by the contractor to match color, size, style and texture.

Where unacceptable conditions are found, the Contractor shall bring this to the attention of the DFD Construction Representative immediately. A written resolution will follow to determine the appropriate action to be taken.

Beginning installation means contractor accepts existing conditions.

Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings with the respect or regard to the quality, value of materials, appliances or labor used in the work, it shall be rejected

and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

All cables, termination components and support hardware shall be furnished, installed, tested and documented by the Contractor unless noted otherwise.

## **CABLE INSTALLATION**

### **General**

Install all cables in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

Cable shall be suitable for the installation environment through which it passes. General Purpose or Riser-rated installed in a Plenum area shall be in conduit.

Furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices, which may move or wear in a manner to pose a hazard to the cable, shall not be used.

Pull all cable by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to ensure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a "break-away" or other approved method.

Complete all work using qualified personnel utilizing state-of-the-art equipment and techniques. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit, as well as to feed cable and operate pulling machinery.

Pull cable in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed. If any installed cable is kinked to a radius less than recommended dimension it shall be replaced by the contractor with no additional cost to the project.

All wiring shall be run "free-air", in conduit, in a secured metal raceway or in modular furniture as designated on the plan drawings. All cable shall be free of tension at both ends.

Avoid abrasion and other damage to cables during installation.

Pulling Lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellom grips may be used to spread the strain over a longer length of cable.

Manufacturer's minimum bend radius specifications shall be observed in all instances.

A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

### **Protection of cable from foreign materials:**

Provide adequate physical protection during construction to prevent foreign material application or contact with any cable type.

Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of

1 paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid  
2 or compound that could come in contact with the cable, cable jacket or cable termination  
3 components.  
4  
5 Overspray of paint on any cable, cable jacket or cable termination component will not be  
6 accepted.  
7  
8 Use of any cleaning agents to remove overspray shall be per the cable manufacturer's  
9 written consent.  
10  
11 It shall be the Contractor's responsibility to replace any component in its entirety affected by a  
12 foreign material. This shall be at no additional cost to the project.  
13  
14 Should the manufacturer and/or warrantor of the structured cabling system desire to physically  
15 inspect the installed condition and certify the validity of the structured cabling system (via a  
16 signed and dated statement by an authorized representative of the structured cabling  
17 manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of  
18 having the affected cables replaced.  
19  
20 In the case of plenum cabling, in addition to the statement from the manufacturer, the  
21 Contractor shall also present to the Owner a letter from the local Authority Having  
22 Jurisdiction stating that they consider the plenum rating of the cable to be intact and  
23 acceptable.  
24  
25 **TELECOMMUNICATIONS OUTLET**  
26 **General**  
27 Outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on Surface  
28 Raceway and in modular furniture.  
29  
30 Mount level.  
31  
32 Unless noted otherwise on drawings, default mounting height (from finished floor to center line of  
33 outlet) in new installation shall be as follows:  
34  
35 Standard Voice & Data Outlet 18-inches  
36  
37 Outlet for Wall-Mounted Telephone 46-inches.  
38  
39 **Wireless Access Point (WAP) Locations**  
40 Unless noted otherwise on drawings, mount Telecommunications Outlet intended for use with a  
41 Wireless Access Point (WAP) as follows:  
42  
43 Drop Ceilings - Cut ceiling tiles and deliver cabling into 2-gang outlet box mounted on a  
44 grid box hanger (a.k.a. "tile bridge").  
45  
46 Exposed Ceilings (surface mount) - cabling piped out of tray to a 2-gang outlet box.  
47  
48 Drywall - deliver cable into flush mounted 2-gang outlet box.  
49  
50 Reduce opening to 1-gang using "mud ring".  
51  
52 Provide cable slack at each location to allow for re-location of the TO. Unless noted  
53 otherwise on the project drawings, slack length (each cable) shall be 20-feet.  
54  
55 Telecommunications Outlet locations for Wireless Access Points as shown on drawings are  
56 approximate. Coordinate final locations with Agency.  
57

## **CABLE TERMINATION**

### **General**

At the Telecommunications Rooms, position all Data and Voice Cables on termination hardware in sequence of the Outlet I.D. starting with the lowest number.

Termination Hardware (Blocks and Patch Panels) Positioning and Layout must be reviewed and approved by the Engineer prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.

### **Cable Termination –Blocks**

#### General

Refer to the Project Drawings and Part 2 of this section which indicates mounting requirements for Termination Blocks.

Coordinate the placement of blocks with other cabling where applicable.

Unless spare capacity is noted on project drawings:

Provide Horizontal Blocks to accommodate minimum of 20% growth in the quantity of stations relative to the initial installation, adjusted upward to the nearest commercially available block size.

Provide Intra-building Backbone Blocks to accommodate minimum 20% growth, adjusted upward to the nearest commercially available block size. Assume (1) that all four pairs in horizontal cabling designated as for "Voice" are cross connected to the backbone cabling.

Size Blocks for Inter and Intra-building Copper Backbone Cabling to include 30% growth relative to initial requirements, adjusted upward to the nearest commercially available block size.

Provide cable management hardware (e.g. D Rings and cable guides) to neatly and securely route the cable from cable tray to the cable termination hardware.

The Height of the Voice Termination Field shall not exceed 6-feet (72-inches) above floor level to facilitate cable maintenance.

Position Blocks on which Backbone and Station Cabling are terminated in separate columns. Position Backbone Cabling to the Left; Station cabling to the Right. Position Blocks close proximity to simplify installation and subsequent tracing of cross-connect wiring. Where new cabling is to be integrated with existing cabling at the building entrance, it will be the responsibility of the Contractor, in cooperation with the Owner, to coordinate placement of Voice Termination hardware with the Local Exchange Carrier(s) serving the site.

Route cables to wall-mounted blocks from below the blocks in a manner that will facilitate growth.

#### Cable Management

Provide Horizontal Troughs incorporating split plastic distribution rings to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block.

Position Rings between the Backbone and Station blocks for vertical routing of jumpers and/or cross-connect wiring.

#### Termination

For termination of Horizontal Cabling, use four-pair (e.g. C4-type) clips. The twenty-fifth pair of each row on the 110 type block located at the Horizontal Cross-connect (e.g. Telecom Room / IDF) shall not be used for termination of horizontal voice cable.

For termination of Backbone Cabling, use five-pair (e.g. C5-type) clips.

1  
2 Ensure that the twists in each cable pair are preserved to within 1.0-inch of the termination for all  
3 Voice UTP backbone cables and within 0.5-inch for Category 5e and Category 6 cables. Remove  
4 cable jacket only to the extent required to make the termination.  
5

#### 6 Cross Connect Wiring

7 The Owner shall be responsible for the "Cross-connect" wiring between Horizontal and Backbone  
8 cabling.  
9

#### 10 **Cable Termination - Modular Patch Panels**

11 Install Data Patch Panel(s) in a fashion as to allow future station cabling to be terminated on the  
12 panel without disruption to existing connections.  
13

14 Size Data Patch panels to accommodate a minimum of 20% growth in the quantity of stations  
15 relative to the initial installation.  
16

17 At Telecommunications Outlet and Data Patch Panel, ensure that the twists in each cable pair are  
18 preserved to within 0.5-inch of the termination for Data cables. The cable jacket shall be  
19 removed only to the extent required to make the termination.  
20

#### 21 **IDENTIFICATION AND LABELING**

22 Refer to Section 27 05 53 "Identification for Communications Systems" for Identification and  
23 Labeling guidelines for this Project.  
24

25 Label all Backbone and Horizontal Cable, Outlet Faceplates, and Termination components (e.g.  
26 Voice Termination Blocks & Modular Patch Panel).  
27

28 Prior to installation, provide samples of all label types planned for the project. These samples  
29 shall include examples of the lettering to be used.  
30

#### 31 **TESTING AND ACCEPTANCE**

##### 32 **General**

33 Prior to testing, provide a summary of the proposed test plan for each cable type including  
34 equipment to be used, set-up, test frequencies or wavelengths, results format, etc. The method  
35 of testing shall be approved by the Engineer. Failure to provide the above information shall be  
36 grounds for the Owner/Engineer to reject any and all Documentation of Results on related testing  
37 and to require a repeat of the affected test.  
38

39 Visually inspect all cabling and termination points to ensure that they are complete and conform  
40 to the wiring pattern defined herein. Provide to the Engineer with a written certification that this  
41 inspection has been made.  
42

43 Conduct acceptance testing according to a schedule coordinated with the Agency and DFD.  
44

45       Representatives of the Owner may be in attendance to witness the test procedures.  
46       Provide a minimum of one (1) week advance notice to allow for such participation.  
47

48       Provide Test Plan as part of this notice or sooner.  
49

50 Supply all equipment and personnel necessary to conduct the acceptance tests.  
51

52       All equipment used in testing shall be maintained and calibrated per manufacturer's  
53       guidelines. Provide documentation of equipment calibration.  
54

55 Document all tests. Refer to the Article "DOCUMENTATION" below which details requirements.  
56

57 Perform tests related to connected equipment of others only with the permission and presence of  
58 Contractor involved.  
59

All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the contractor. The applicable tests shall then be repeated.

Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

#### **Horizontal 4-pair Copper Cabling**

##### General

Testing shall be from the Telecommunications Outlet to the Data Patch Panel (or Wiring Block) at the TR on which the cables are terminated.

The cabling must pass all the specified requirements. Conditional passing test results that are within the measurements accuracy of the test equipment (e.g. "\*\*PASS") are not acceptable.

When the TO is located on/in the wall behind modular furniture, a patch cord may be inserted into the TO to allow the furniture to be returned to its normal location. Cable testing, in this case, will be done with the patch cord. If the cable test fails only due to the length of the patch cord, the DFD will accept the cable as passing. Provide list of such locations in Test Results documentation.

Horizontal "Station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on the Modular Jack).

Correct any defective, split or mis-positioned pairs.

Additional testing of Cabling Systems rated at TIA Category 5e and higher shall be performed to confirm proper functioning and performance.

##### Performance Testing

Testing of the Transmission Performance of station cables shall include the following:

- Length
- Attenuation (Insertion Loss)
- Pair-to-Pair NEXT Loss
- PSNEXT Loss
- Attenuation-to-Crosstalk Ratio (ACR)
- Power-sum ACR (PSACR)
- Propagation Delay
- Delay Skew
- Return Loss

Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify "PASS" on each cable and display the specified parameters - comparing test values with standards based "templates" integral to the unit. Test method shall document all parameters specified by the standard including margins over minimal compliance.

Performance testing shall be per ANSI/TIA-568-C.2 Permanent Link test configuration and procedures

Where margin(s) over compliance with the identified standard(s) is specified, the contractor shall field verify that the necessary margins are met and take corrective actions necessary to remedy out-of-spec links.



The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.

In order to establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an 8-position Modular plug (8-pin) to facilitate testing. Net Propagation Velocity (NPV) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable. This requirement can be waived if NPV data is available from the cable manufacturer for the exact cable type under test.

In the event results of the tests are not satisfactory, the Contractor shall make changes as necessary, and shall then repeat the test or tests which disclosed faulty or defective material, equipment or installation method, and shall make additional tests as the Engineer deems necessary at no additional expense to the project or user agency.

#### Special Considerations

Where Cabling is Terminated in a Modular Plug at the device location (e.g. Video Surveillance Camera or Wireless Access Point), use one of the following methods:

Use Modular-Jack to Modular Jack adapter cord.

or

Use tester configured with Channel Test head at "plug end". This method must be supported by the test equipment manufacturer.

Where the horizontal cabling includes an interconnect (e.g. where a zone cable is extended from a Consolidation Point to the work area Telecommunications Outlet (TO)), testing of the Permanent Link shall be from the Horizontal Cross-connect at the Telecom Room to the TO and include the interconnect.

#### Voice Channel Test

Where cross-connection of cabling sub-systems (e.g. Station & Backbone) by the Contractor is specified, test each subsystem separately as defined. Test Voice Channel after the cross-connect wiring/patching is complete.

Voice Channel Test confirms the end-to-end voice transmission between the Main Cross-connect and the Telecommunications Outlet (Voice) and include patch cords/jumper cables.

All pairs shall be tested and are to be free of shorts, verified for continuity, pair validity, polarity, and conductor position.

Correct any mis-positioned pairs or cross-connect wiring. Replace any patch cords/jumper cables which cause the Voice Channel test to fail and retest Channel.

Performance testing on the Voice Channel is not required.

#### **Backbone Copper Data Cabling**

Not applicable to this project.

#### **DOCUMENTATION**

##### **General**

Upon completion of the installation, provide project documentation to the Engineer for review. Documentation shall include the items detailed in the sub-sections below. Provide approved test results and documentation in Operations and Maintenance Manuals.

Submit documentation of Test Results in electronic form for review and distribution.

Where documentation provided in electronic form requires unique software (e.g. NATIVE formats) other than Adobe Acrobat Reader for viewing test results, provide one (1) copy of such software. The software shall run on a MICROSOFT *Windows*-based personal computer supplied by the Owner. Software shall include license if applicable.

Organize documentation by Building and Telecom Room.

Provide final documentation on CD-ROM. Interim documentation may be submitted to the Engineer for review via email, FTP, CD-ROM or other electronic means.

Name file(s) and records to include building, route or other cable identifiers that match labeling formats used. Prefix file name with the DFD project number. ?

Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Engineer, provide copies of the original test results.

Submit Documentation within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). Interim documentation on a shorter schedule may be required to accommodate occupancy or other requirements. Confirm requirements during construction.

This is inclusive of all test result and *draft* as-built drawings. Draft drawings may include annotations done by hand.

Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.

The Engineer may request that a 10% random field re-test be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

#### **Test Data - Copper Media**

Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

Submit Test Results for each Horizontal Link in electronic form as follows:

In the native format of the test instrument (e.g. .flw for Fluke, .sdf for Agilent or Ideal, etc.).

Summarized in a fashion that includes a graphical display of key test parameters. The Summary shall be in Adobe Acrobat (.pdf) format and include all records. Individual .pdf documentation of individual records (e.g. for each cable) are not required.

Submit Test Results for each Backbone Copper Cable in electronic form in the native format of the test instrument.

#### **AS-BUILT CONSTRUCTION DRAWINGS**

Provide Record Drawings which denote as-built information.

Include cable routes and outlet locations.

Identify Telecommunications and other low-voltage Outlet locations by their sequential number as defined elsewhere in these documents. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

The Division of Facilities Development - through the Consultant - will provide floor plans in paper and electronic (*AutoCAD* .dwg) formats on which as-built construction information can be added.

1 These documents will be modified accordingly by the contractor to denote as-built information as  
2 defined above and returned to the Consultant for acceptance. The schedule for creation of these  
3 drawings, including interim and final sets, shall be coordinated during construction to  
4 accommodate scheduled occupancy of documented area(s).

5  
6 Annotate the base drawings and return to the A/E in hard copy (same plot size as  
7 originals) and electronic (*AutoCAD* .dwg; 2007 file format) form. Refer to DFD "Policy  
8 and Procedure Manual for Architects/Engineers And Consultants" for file format, naming  
9 and other applicable guidelines.

10  
11 Identify each drawing submitted by the Contractor as part of the Project Documentation  
12 as an "As-built" drawing and include a) the contractor name and/or logo, and b) the date  
13 of the drawing.

14  
15 Retain all fonts, color, layer, Model Space/Paper Space conventions established in the  
16 base drawings by the Contractor in preparation of the As-built drawings.

17  
18 Prior to generation of the drawings, provide a sample file and test plot to the Engineer for review  
19 and approval.

20  
21 All documentation, including hard copy and electronic forms shall become the property of the  
22 State.

#### 23 **WARRANTY**

24 See Division 1, GENERAL CONDITIONS, and GENERAL REQUIREMENTS - Guarantee  
25 Documents for general requirements.

26  
27 Minimum Warranty period for Structured Cable System sub-systems shall be as follows:

28  
29 Horizontal Copper Permanent Link – 15 years. Warranty shall be direct from  
30 manufacturer(s) of cabling and connecting components to Owner.

31  
32 Warranties shall include all labor, material, and travel time.

33  
34 Provide Warranty Certification by the of the Horizontal Copper Permanent Link by the  
35 manufacturer(s) of cabling and connecting components as part of system documentation.

36  
37 Submit documents to manufacturer as required for Extended Warranties.

#### 38 **AS-BUILT COMMUNICATION CABLE COSTS**

39 The contractor shall determine the "installed" price for the telecommunication cabling and submit  
40 to the DFD for future reference. Costs are to include material, labor, installation, testing,  
41 documentation, manuals, training, warranty, and the telecommunications proportion of the  
42 Schedule of Values consisting of general conditions, bond, mobilization, record drawings, punch  
43 list, cleanup, and demobilization.

44  
45 Costs shall include the following (as applicable):

- 46  
47  
48  
49 1) Average installed cost of Horizontal Permanent Link which includes (1) Voice and (1)  
50 Data cable from the Horizontal Cross-connect to the Telecommunications Outlet.  
51  
52 2) Average installed cost for a coaxial run from the F connector to the AV source equipment.  
53  
54 3) Average installed cost for an intra-building backbone fiber optic cable (state the number  
55 of fibers/cable, fiber types and average length of cable).  
56  
57 4) Installed cost for inter-building backbone fiber optic cables (state the number of fibers and  
58 fiber type(s)).  
59

1 Submit to DFD on request as part of system documentation.

2  
3 **CONSTRUCTION VERIFICATION**

4 Contractor is responsible for utilizing the construction verification checklists supplied under  
5 specification Section 27 08 00 in accordance with the procedures defined for construction  
6 verification in Section 01 91 01 or 01 91 02.

7  
8  
9 **END OF SECTION**

DIVISION 27 - COMMUNICATIONS

**SECTION 27 11 00**  
**COMMUNICATIONS EQUIPMENT ROOM FITTINGS**  
*BASED ON DSF MASTER COMMUNICATION SPEC DATED 03/01/2014*

**PART 1 - GENERAL**

Applicable provisions of Division 0 and 1 shall govern work of this Section.

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PART 1 - GENERAL

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**SCOPE**

This Section describes the general, product and execution requirements relating to equipment required in the fit-out of the Communications Equipment Room(s) for the Project.

Provide all labeling as detailed in this and related Sections.

**RELATED WORK**

Section 01 91 01 or 01 91 02 - Commissioning Process

Section 26 05 26 - Grounding and Bonding for Electrical Systems

Section 27 05 53 - Identification for Communications Systems

Section 27 08 00 - Commissioning of Communications

Section 27 10 00 - Structured Cabling

**REGULATORY AND STANDARDS REFERENCES**

All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Wisconsin Electrical Code and present manufacturing standards. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

Other applicable standards are as follows:

- ANSI/IEEE C2 - National Electrical Safety Code
- NFPA 70- 2011 - National Electrical Code
- SPS Chapter 316 – Wisconsin Dept. of Safety and Professional Services Electrical Code
- ANSI/TIA-568-C.0, -568-C.1, -568-C.2, -569-C, -606-B and ANSI-J-STD-607-B (with exception) and TIA/EIA Standards referenced therein.

- IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

## **WORK SEQUENCE**

Refer to Section 27 10 00 – Structured Cabling.

## **SUBMITTALS**

Refer to Section 27 10 00 – Structured Cabling.

## **WORK BY STATE AND/OR USER AGENCY**

None.

## **COOPERATION**

Refer to Section 27 10 00 – Structured Cabling.

## **PROJECT RECORD DOCUMENTS**

Refer to Section 27 10 00 – Structured Cabling.

## **DRAWINGS**

Refer to Section 27 10 00 – Structured Cabling.

## **PART 2 - PRODUCTS**

### **EQUIPMENT CABINET (WALL MOUNT)**

Where identified on the drawings, wall mounted equipment cabinets shall house all termination components installed under this contract.

Be of a “three-section” construction including (a) wall-mount section which incorporates cable entry, (2) center section and (c) Door. Each section shall be hinged to facilitate access. Hinges shall be configurable to open LEFT OR RIGHT.

The Wall-mounted section shall incorporate knock-outs (top and bottom) for cable access.

The Door shall be solid and lockable. Door depth shall be 2-inches or greater. [Door shall be lockable and furnished with two (2) keys. Doors on all cabinets furnished under this contract shall use the same key.]

Door shall be at least 25-inches in width. (It is understood that this may require a custom configuration. Use of standard cabinet designs with extended mounting rails is to be considered).

Hardware mounting depth (from front of channel upright to wall) shall be 18-inches (minimum).

The cabinets shall be constructed of painted Steel or Aluminum.

Dimensions:

Minimum usable mounting height – 15 RU (RU = 1-3/4")

Mounting depth – 21 inches

Cabinet shall have a load-bearing capacity of 100 lbs. or greater.

The cabinet shall be configured as to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting and

tapped to accept 12-24 screws. The cabinet shall be vented to allow for airflow through the cabinet.

Cabinet(s) shall be equipped with vertical and horizontal cable management hardware, in the form of rings and guides, as to allow an orderly routing of optical fiber and twisted pair jumpers from the patch panel to the customer provided network equipment. At a minimum, provide one such horizontal jumper management panel with each cabinet.

Each rack shall be supplied with a minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties and shall be supplied with a supply of spare screws (minimum of 24).

## **MISCELLANEOUS MATERIALS**

### **Power Strip / Surge Suppressor**

Power Strip / Surge Suppressor shall:

- Be rack mountable (19-inch rack)

- Be compliant with UL-1449, UL-1283 and UL-497A.

- Provide Transient suppression to 13 kA. Protection shall be in all 3 modes (hot-neutral, hot-ground & neutral-ground).

- Meet or exceed IEEE 587 Category A & B specification.

- Provide High Frequency Noise Suppression as follows:

  - >20 dB @ 50-kHz

  - >40 dB @ 150-kHz

  - >80 dB @ 1-MHz

  - >30 dB @ 6- to 1000-MHz

- Provide a minimum of 320 Joules of AC Energy Absorption.

- Be equipped with a 12-foot power cord

- Provide a minimum of six (6) outlets

## **PART 3 - EXECUTION**

### **GENERAL**

Refer to Project Drawings which indicate Equipment Room layout

Furnish and install hardware and equipment as shown on drawings and as specified above.

It is the contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

Beginning installation means contractor accepts existing conditions.

Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings with the respect or regard to the quality, value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

### **WALL MOUNT RACK**

Refer to the Project Drawings for Quantities by location.

1 Mount all hardware and equipment between 48" and 79" above floor level. This is to afford easy  
2 access and, in the case of the lower limit, prevent damage to the components. Positioning of  
3 hardware should be reviewed and approved by the Engineer and DFD Construction  
4 Representative prior to installation.

5  
6 Provide cable management hardware on back of rack(s) to allow an orderly and secure routing of  
7 cabling.

8  
9 Provide horizontal cable management hardware adjacent to (above or below) each row of jacks in  
10 a Modular Patch Panel.

11  
12 Supply each rack with a minimum of twelve (12) releasable (e.g. "hook & loop") cable support  
13 ties.

14  
15 Where Cable Termination Hardware is wall mounted, establish a cable pathway for jumpers  
16 routed from the Equipment Rack(s) to the wall. This shall be in the form of slotted ducts, troughs,  
17 "D" rings or other means. Routing of jumpers via the overhead ladder rack system is not  
18 acceptable. The proposed method shall be included in the submittals required by this document  
19 and shall be approved by the Engineer prior to installation.

20  
21 Bond each rack via on-rack ground bar to the Telecommunications Ground Busbar (TGB) using a  
22 #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket or GREEN jacket with  
23 one or more yellow stripes per NEC paragraph 250.119).

24  
25 Install ground bar such that there is a bond between it and rack. Paint should be  
26 removed from the rack at the connection point and the mounting screws should be of the  
27 thread-forming type.

## 28 29 **MISCELLANEOUS MATERIALS**

### 30 31 **Power Strip / Surge Suppressor**

32 Unless noted otherwise on project drawings, provide (1) Power Strip / Surge Suppressor for  
33 powering of the network electronics (by others):

34  
35 At the Main Equipment Room

36  
37 At each Telecommunications Room (as applicable).

38  
39 Install per manufacturer's recommended practices.

40  
41 Confirm requirements for powering of UPS's with Division 26 contractor.

42  
43 Install per manufacturer's recommended practices.

44  
45 **END OF SECTION**